

The Control of Insect Pests and Plant Diseases



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THE CONTROL OF INSECT PESTS AND PLANT DISEASES

Few growers of crops realize the annual loss caused by insects and fungous diseases. It is safe to say that in the State of New York the loss from these sources alone exceeds the amount annually appropriated by the Legislature for conducting the State's business. The results of careful spraying demonstrations conducted by the growers themselves show that the average annual preventable loss to potato growers in this State, from blights and insects, is fifty bushels or more to the acre. This represents a yearly loss of more than ten million dollars, which might be prevented by an expenditure of less than ten dollars an acre for spraying. A careful estimate of losses in New York from the loose smut of oats shows that five per cent of the crop is destroyed annually by this fungous disease, a net loss of about two million bushels. The losses from apple scab, codling moth, and San José scale, from peach yellows and fire blight, and from all the other common insect pests and destructive plant diseases, if they could be accurately calculated, would show a grand total of appalling magnitude. This tremendous annual tax on the plant production of the State might be greatly reduced by the proper application of known methods of control.

The method of control to be employed for a given insect pest or fungous disease must be determined by the nature and habits of the enemy and by the character of the crop attacked. Plants can seldom be cured of diseases, as are men and animals. They must be protected from the attack. If sucking insects are to be controlled, something must be applied which will kill when it hits them, as nicotine solution, or which will give off a lethal gas; if biting insects are to be combated, the fruit and foliage of the plants may be sprayed or dusted with a poison which when eaten will destroy the pest. Many fungous diseases are prevented by spraying the plants before the disease appears, with a mixture destructive to the fungus but harmless to the plant. The poisons that destroy fungi are not always effective against insects, and hence we have both fungicides and insecticides. Often these can be combined in one mixture for insect and fungous pests of certain crops, as are, for example, lead arsenate and lime-sulfur in controlling codling moth and apple scab.

It is not to be supposed that spraying is the only means of controlling diseases. Many fungi are perpetuated from year to year in or on the seeds of the crop, as, for example, the smut of oats and wheat and the pod spot of beans. In such cases it becomes necessary to treat the seed in order to kill the fungus, or to select seed free from the disease. Special

methods of cultivation, soil treatment, and sanitation are means of controlling certain pests and maladies, to be practiced, as is spraying, only in those cases in which they have been shown to be especially applicable.

In order to apply successfully these measures for control of a given disease, certain factors must be taken into consideration. For example, in spraying apple trees for scab, the stage of development of buds, blossoms, and fruit, and of the scab fungus, together with the character of the weather rather than the day of the month, must be the guide in making the application.

For nearly all fungous diseases the application should be made before rains, not after. Fungus spores are scattered and germinate during rains, seldom after. The plants should be protected by having the mixture on when the rain comes. Bordeaux mixture and lime-sulfur do not wash off easily. The application should be made thoroughly. Every leaf and fruit must be coated in order to be protected. A nozzle that gives a fine spray should be used. This requires good pressure behind the nozzle. The amount of pressure required to do good work varies with the type of nozzle. It should never be less than 200 pounds, and some types of nozzles require 300 pounds in order to do the best work.

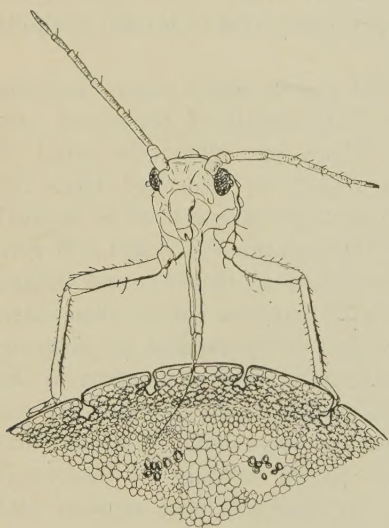


FIGURE I. A PLANT LOUSE

A sucking insect, showing the method of feeding

Dusting should be done when the air conditions permit the best distribution possible within the effective period. Copper-lime dusts should be applied when the air is quiet and the foliage is wet. Sulfur dusts may be applied when the foliage is dry. Nicotine dusts require high temperatures at the time of application, to be most effective.

Timeliness and thoroughness are more important factors in the control of diseases and insect pests than are the particular mixtures of poisons used.

For purposes of control, insects are divided into two great classes: (1) Chewing insects, or those having jaws by means of which they bite off and eat pieces of the tissue of the plant.

Examples are Colorado potato beetle, cankerworm, and codling-moth caterpillar. (2) Sucking insects, or those with a beak containing four bristles united to form a slender tube. The bristles are inserted into the

plant, and through them the insect sucks out the sap (figure 1). Examples are squash stinkbug, San José scale, and plant louse.

Chewing insects are usually controlled by applying to their food such poisons as lead arsenate or calcium arsenate. Sucking insects cannot be reached in this way, but must be killed by contact insecticides, such as nicotine, oils, poisonous gases, or other substances. In fighting sucking insects, thorough and skillful work is required, since every insect must be hit by the spray; while with chewing insects, it is necessary merely to apply the poison thoroughly to the food-plant.

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ALFALFA

Dodder (Figure 2)

Dodder is a parasitic seed plant which twines around alfalfa plants, forming a tangled mat of yellow threads which suck the juices from the alfalfa. Infested spots, which enlarge rapidly, should be mowed closely and the stubble sprinkled with kerosene,

covered with dry hay, and burned. Only seed free from dodder should be used. Samples of seed may be sent to the experiment station at Geneva to be examined for presence of dodder. Alfalfa seed can be cleaned by sifting it through a 20x20-mesh sieve made of No. 34 wire.

Leaf spot (Figure 3)

Alfalfa leaf spot, the most serious fungous disease of the crop in this State, causes yellowing, premature dropping of the leaves, and increased shattering during harvest. This loss of leaves results in low yield, and in poor quality of hay since the leaves are higher in food value than the stems which are left. New seedlings, if badly diseased, should be topped but never mowed closely. When older fields are attacked, the hay should be cut a few days early in order to avoid loss of leaves and to permit a new growth, which will usually outgrow the disease.

APPLE

Aphis

Three species of plant lice are pests of the apple: the grain aphis, the green aphis, and the rosy aphis. The rosy aphis is the most serious, and produces the clusters of puckered "aphis apples," so called. All three species pass the winter in the form of black, shiny eggs on the twigs and branches. The eggs hatch as the buds are opening (figure 4), the rosy aphis being the last to appear. All three species can be controlled by a thorough application of nicotine sulfate, 1 pint in 100 gallons of spray, when the leaves of the fruit buds are out about $\frac{1}{2}$ inch and are beginning to curl backward. (See delayed-dormant spray, page 12.)



FIGURE 2. DODDER ON ALFALFA
The slender, cord-like stems and the bunches of small white flowers are shown

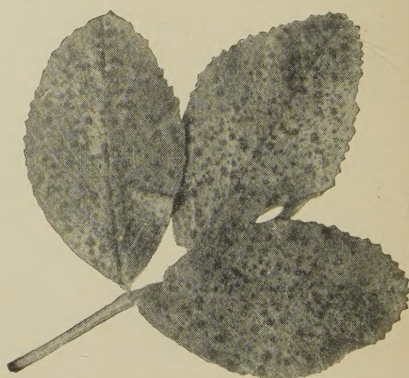


FIGURE 3. ALFALFA LEAF SPOT

The small, white, **Apple maggot** apple maggots make brownish, winding burrows in the flesh of the apple fruit, particularly in the summer and early fall varieties. When full-grown, the maggot leaves the fruit, passes into the ground, and finally transforms into a fly. The flies appear during July, and feed by scraping and sucking material from the surface of the leaves and the fruit. They may be poisoned before they lay their eggs, by spraying with a mixture of $2\frac{1}{2}$ pounds of lead arsenate to 100 gallons of lime-sulfur at summer strength (1 to 40). The spray should be applied when the flies first appear in numbers, usually about July 4. If the infestation has been severe, the application should be repeated in ten days to two weeks.

The apple redbugs are small, bright red, sucking bugs, which

appear on the trees and puncture the newly set fruit, causing the apples either to fall or, if they mature, to be knotty, as shown in figure 5. Where redbugs are injurious, nicotine sulfate, 1 pint to 100 gallons of spray, should be added to the spray in the calyx application (page 12).

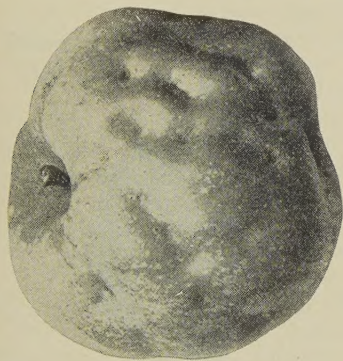


FIGURE 5. MATURE APPLE SHOWING INJURY BY REDBUGS

Bud moth

The small, chocolate brown, black-headed caterpillars of the bud moth web together and devour the tender leaves and flowers of the opening buds. The summer-brood caterpillars injure the fruit by eating out clusters of shallow holes resembling codling-moth stings. The bud moth is seldom serious where the regular schedule of sprays is thoroughly applied. Nicotine sulfate, 1 pint in 100 gallons, in the delayed-dormant application is the important factor in control.



FIGURE 4. APPLE APHIDS CLUSTERING ON OPENING BUDS

This stage is too early for control of the rosy aphid

Apple tent-caterpillar

The apple tent-caterpillar passes the winter in the egg stage. The eggs are glued in ring-like, brownish masses (figure 6) around the smaller twigs of the trees, where they may easily be found and destroyed. The caterpillars appear in early spring, devour the tender leaves, and build unsightly nests on the smaller branches.

They are readily killed by the lead arsenate in the delayed-dormant spray (page 12).



FIGURE 6. EGG MASS OF APPLE TENT - CATERPILLAR

Cankerworm

Cankerworms are small measuring worms, or loopers, which defoliate the trees in May and June. The female moths are wingless, and in late fall or early spring crawl up the trunks of the trees to lay their eggs on the branches. This ascent of the females may be prevented by sticky bands. Cankerworms are never a pest in well-sprayed orchards. Infested trees should be sprayed once or twice before the blossoms open, with lead arsenate, 3 pounds in 100 gallons of spray.

Case-bearer

The small case-bearer caterpillars live in pistol- or cigar-shaped cases about $\frac{1}{4}$ inch long, which they carry about with them. They appear in spring on the opening buds, and are usually well controlled by lead arsenate, 3 pounds to 100 gallons of spray in the delayed-dormant and following sprays.

Codling moth**(Figure 7)**

The pinkish white caterpillar of the codling moth causes practically all of the wormy apples in New York. The eggs are laid by the small moth on the apple leaves and fruit. The first-brood caterpillars start to hatch about four weeks after the petals have fallen, and continue hatching for about a month. They enter the fruit and become full-grown in July and August, leave the fruit, and crawl down the trunk of the tree to spin their cocoons under the bark. Some of them change to moths for a second brood, but the greater part remain in their cocoons for the winter. An application of lead arsenate,

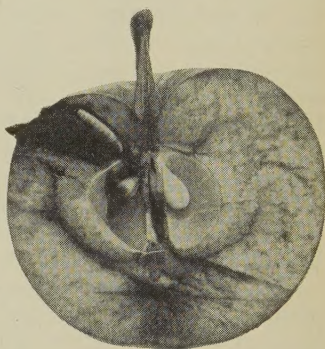


FIGURE 7. CODLING-MOTH CATERPILLAR IN AN APPLE



FIGURE 8. JUST RIGHT TO SPRAY

Two apple blossoms from which the petals have just fallen. The calyx lobes are widely spread

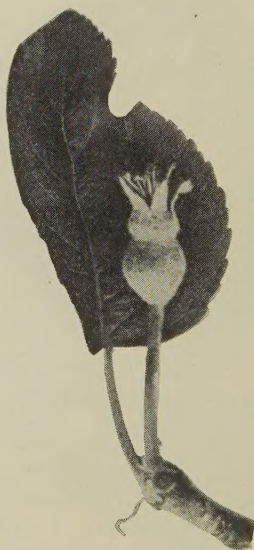


FIGURE 9. ALMOST TOO LATE TO SPRAY EFFECTIVELY

The calyx lobes are nearly together

3 pounds in 100 gallons of spray, when most of the blossom petals have fallen, will put a coating of poison in the calyx cup (which is open then but closes later) to kill the caterpillars which later try to enter the fruit through the blossom end. Caterpillars that attempt to enter the fruit through the side can be killed by lead arsenate, $2\frac{1}{2}$ pounds in 100 gallons of spray, applied four weeks after the petals have fallen and again two weeks later. In years when the second brood is large, another spray application may be advisable early in August.

Fruit-tree leaf-roller

The green, black-headed caterpillars of the fruit-tree leaf-roller attack the opening buds, web together the expanding leaves and blossoms, and eat holes in the young apples. They attack pears also. The insects pass the winter in the egg stage. The eggs are deposited in flat masses on the twigs, and are covered with a varnish-like substance. Where fruit injured by the leaf-roller amounts to 10 per cent of the crop at picking time, an 8-per-cent lubricating-oil emulsion spray should be applied to kill the eggs. The spray should be thoroughly applied when the buds have started to swell but before they show any green. This should be followed by lead arsenate at the rate of 6 pounds to 100 gallons of spray in the pre-blossom and calyx applications.

Green fruit-worm

When full-grown, the caterpillars of the green fruit-worm are somewhat larger than those of the fruit-tree leaf-roller, being about 1 to $1\frac{1}{2}$ inches in length, and are of a light green color with whitish stripes. They injure the fruit in much the same way as does the fruit-tree leaf-roller. They may be controlled by early arsenical sprays, as recommended for the leaf-roller.

Leaf blister-mite

The presence of the minute leaf blister-mite is indicated by small, irregular, brownish blisters on the leaves. The trees should be sprayed in late fall or early spring with lime-sulfur of the strength recommended for San José scale.

Plum curculio (See page 38)

Where apple orchards are bordered by woods, stone walls, or other shelter for the overwintering beetles, the plum curculio often causes severe damage to apples by its feeding and egg-laying punctures. Injured fruit drops early or is scarred and deformed. The late pre-blossom and calyx sprays (spray schedule, page 12) are important in control. Where the pest is serious, an extra spray of lime-sulfur and lead arsenate should be applied one week after the petals have fallen.

Round-headed borer

The usual method of controlling the round-headed borer is to dig out the insects or kill them with a wire. Painting the lower part of the trunk of the tree, to the height of 1 foot, with a mixture of $2\frac{3}{4}$ ounces of calcium cyanide and 1 ounce of raw linseed oil, is a promising new method of control.

San José scale (Figure 10, A)

The San José scale is nearly circular in outline and about the size of a pinhead. Where abundant it forms a crust on the branches of the tree and causes small red spots on the fruit. The insects pass the winter as partly grown scales which mature in June and give birth to living young. In New York there is only one full generation and a partial second generation. The San José scale is not at present a serious pest in well-sprayed orchards in this State, and special treatment is necessary only occasionally. Where the scale has become abundant, it can be controlled by spraying with lime-sulfur, 11 gallons in 100 gallons of spray mixture, when the buds are out $\frac{1}{4}$ to $\frac{1}{2}$ inch (see delayed-dormant spray, page 12).

Scurfy scale (Figure 10, B)

The whitish, pear-shaped, scurfy scale, about $\frac{1}{8}$ inch in length, often incrusts the bark, giving it a scurfy appearance. Spraying should be done as recommended for the San José scale.

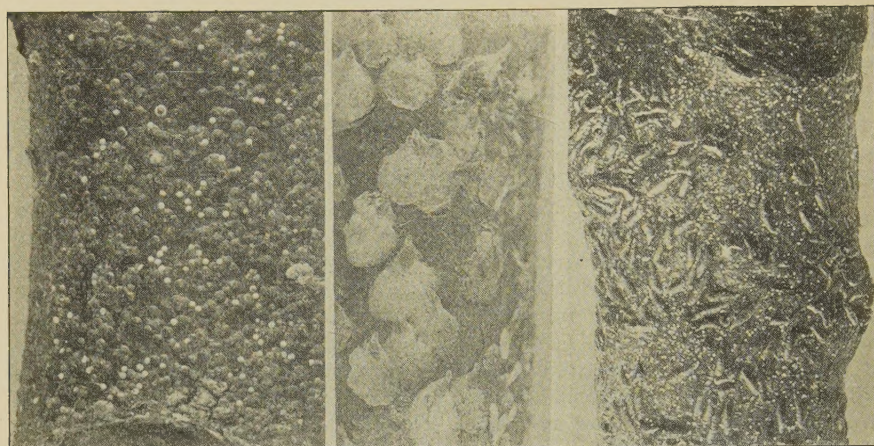


FIGURE 10. THE THREE COMMON SCALES INFESTING THE APPLE
A, San José scale; B, scurfy scale; C, oyster-shell scale

Oyster-shell scale
(Figure 10, C)

Fire blight
(Figure 11)

The oyster-shell scale is an elongate scale $\frac{1}{8}$ inch in length, resembling an oyster shell in shape and often incrusting the bark. Spraying should be done as recommended for the San José scale. The fire-blight disease shows similar symptoms on all affected plants—apple, pear, quince, crab apple, apricot, and occasionally cherry and plum. Practically all parts of a fruit tree are likely to be affected, and, in the several cases, the disease is known as *blossom blight*, *twig blight*, *fruit blight*, and *canker* (on the limbs). Affected

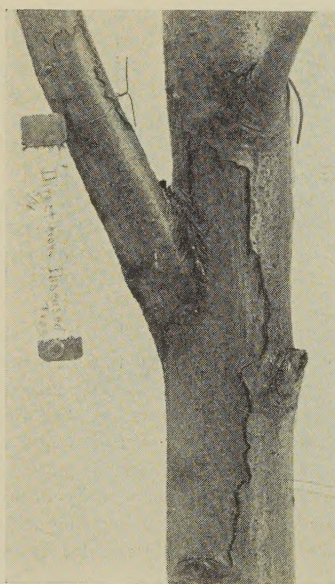


FIGURE 11. BLIGHT CANKER OF APPLE

blossoms suddenly wilt and turn brown; blighted twigs and water sprouts show dead leaves and bark; diseased fruits show water-soaked areas, which finally turn dark; old cankers, often found around the base of a spur or a water sprout, vary in size and show a dark, smooth, sunken surface with a definite cracked margin, while young, active cankers have an indefinite margin and a water-soaked appearance. Sometimes milky or reddish brown drops of liquid ooze from the diseased areas. Cankers on the trunk and on large branches with roughened and scaly bark usually may be detected only by this characteristic ooze or by cutting into the dead bark. The fire-blight bacillus lives over winter in old cankers. In the spring the bacteria multiply and ooze out to the surface of the cankered bark. Being sticky, they are carried by insects (such as bees, wasps, flies, beetles, bugs, aphids, curculios, and leaf hoppers) to blossoms, young fruit, wounded bark, and tender growing parts. Workmen also may carry these bacteria on pruning tools, and wind-blown rain may be a factor in their dissemination.

In general, spraying is of no value in fire-blight control. Fruit spurs and water sprouts should be removed from the trunk and the lower parts of the larger branches of all susceptible trees. All suspicious trees should be inspected for the disease. The cankers should be cut out before they ooze in the spring. Blighted bark may be removed with a knife or a drawshave; the cut should be made well into the healthy bark. The wound should be disinfected with mercuric-cyanide solution, 1 part to 500 parts of water, though no disinfectant is necessary if the cut is made during the dormant period. When dry the wounded surface should be protected with coal tar. If a canker extends halfway around a branch, the branch should be removed entirely. Cuts should be made at a safe distance below the blighted tissue. If the trunk of a tree is diseased halfway round, or more, the tree should be pulled out. All trees with cankers in the roots should be removed. In attempting to find the cause of an outbreak of blight in an orchard (apple, pear, or quince), it is suggested that a search for hold-over cankers be made. An old pear tree in an inconspicuous place on a farm may be the source of much trouble to the orchard. Blighted blossoms, spurs, and twigs should be promptly removed from young trees. This operation is less feasible on larger and older trees, and it is neither profitable, nor essential to the life of the tree, to attempt it on large apple trees. If these measures fail, cooperation with the neighbors may be effective. Fire-blight control is really a community matter involving concerted action.

Frost canker, known also as *sun-scald*, is an injury to the bark of trunk and branches, and occurs most commonly on the southwest side of the tree. It is a winter injury believed to be caused by a rapid fall in temperature of tissues that have warmed up on winter days from exposure to sunshine. Collar rot and crotch cankers also are types of winter injury, but collar blight may be caused by fire-blight bacteria. The dead bark should be removed back to healthy green bark around the injured area, and the wound covered with a good wound dressing (see page 54). The injury should be prevented by endeavoring to have the wood ripen early in the fall, and by taking care not to remove too many branches in pruning, thus exposing the limbs.

New York apple-tree canker (Figure 12)

The New York apple-tree canker, black and rough, is usually found on the main limbs of old trees and is very common on Twenty Ounce apples. The fungus causes also a brown spotting of the leaves and a black rot of mature fruit. Since the fungus enters through wounds, care should be taken not to break the bark. All wounds made in pruning should be promptly painted over. Cankers should be cut out and treated with a good wound dressing (page 54). The body and the limbs of the trees should be soaked when the delayed-dormant application for scale is being made.



FIGURE 12. NEW YORK
APPLE-TREE CANKER

APPLE SPRAY SCHEDULE

Time of application	Spray mixtures	Enemy	Dust mixtures
Delayed dormant When leaves of blossom buds are out $\frac{1}{4}$ to $\frac{1}{2}$ inch	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, 3 lbs.* Nicotine sulfate, 1 pt. Water to make 100 gals. (If scale is present, use 11 gals. lime-sulfur)	Scab Scale Blister-mite Bud moth Case bearer Aphis	90-10 sulfur-lead-arsenate dust No satisfactory dust for scale or blister-mite has been found. For rosy aphis, see below
Pre-blossom When buds of blossom cluster are separated, or earlier if a rainy period threatens Two pre-blossom applications may be needed	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, 3 lbs.* Water to make 100 gals.	Scab Green fruit-worm Bud moth Leaf-roller Case bearer Curculio	90-10 sulfur-lead-arsenate dust.† If conditions are favorable for a bad outbreak of scab, spray as much of the orchard as is possible, using dust to complete the operation on time In combating the rosy aphis with dust mixtures, the most promising means of control is a heavy application of a mixture containing not less than 2 per cent of nicotine, as the blossom buds begin to show pink
Calyx When the last of the petals are falling	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, 3 lbs.* Nicotine sulfate, 1 pt. Water to make 100 gals. (Omit nicotine unless redbug is present)	Scab Codling moth Green fruit-worm Bud moth Curculio Lesser apple-worm Redbug	90-10 sulfur-lead-arsenate dust.† For redbugs, use a 2-per-cent-nicotine dust. If conditions are favorable for a destructive outbreak of scab, spray as much of the orchard as is possible, using dust in a supplementary capacity
Later applications To be determined by weather conditions affecting the development of scab and codling moth	Lime-sulfur, $2\frac{1}{2}$ gals.‡ Lead arsenate, $2\frac{1}{2}$ lbs.* Water to make 100 gals.	Scab Codling moth Curculio Lesser apple-worm Apple maggot	90-10 sulfur-lead-arsenate dust.† During prolonged rainy periods it is advisable to make applications of dust at shorter intervals than are indicated for spray mixtures

* The amount of lead arsenate is given for powder form; if paste form is used, twice as much is required.

† Copper-lime dust may cause russeting, especially at the calyx application. At this time use spray or 90-10 sulfur-lead-arsenate dust.

‡ If the grower is apprehensive of spray injury to apple foliage, the most satisfactory alternative for lime-sulfur solution is dry-mix sulfur-lime spray (page 51). To avoid spotting of fruit in late summer sprays, the lime in the dry-mix sulfur-lime formula may be omitted. The usual amount of lead arsenate may be added.

Scab (Figure 13)

Scab, commonly known among growers as *the fungus*, occurs on twig, leaf, and fruit, but is usually most evident on the fruit.

It is likely to appear first on the under surface of the leaves. The diseased area then is olivaceous in color and slightly darker, changing to brown and finally to nearly black. On the twigs the bark becomes blistered and later ruptures in places, causing a scurfy appearance. The trees should be thoroughly sprayed with lime-sulfur solution or dusted with sulfur, as directed in the schedule on page 12.

Stippen

Stippen, known also as *bitter pit*, and incorrectly as *Baldwin spot* and as *bitter rot*, is a disease of

the fruit in which brown, corky areas exist beneath the skin and may extend deeply into the flesh. The disease may be detected on the surface as dark pits. It is thought to be due to an improper distribution of water by the sap-carrying vessels of the fruit at a time when the fruit is making rapid growth. The disease sometimes develops in storage. Little is known regarding its control.

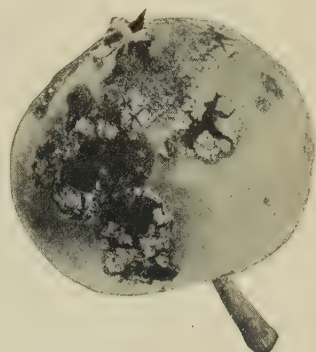


FIGURE 13. APPLE SCAB

APRICOT

(For insect pests, see those under *Peach*, page 33)

ASPARAGUS

The common asparagus beetle

crop clean every
Volunteer plants
gallons of water.

The common orange-and-blue-marked asparagus beetle often causes considerable injury to the tender asparagus shoots and to the plants after they have leafed. The elongate, blackish eggs are laid on end along the shoots and leaves, and hatch into grub-like larvae which also feed on the shoots and the foliage. Cutting the

three to five days will remove the eggs and prevent increase. Poultry given the run of the field will destroy many of the beetles.

The twelve-spotted asparagus beetle, orange-colored and spotted with black, causes injury similar to that done by the common asparagus beetle, but the larvae live in the seeds and cause no damage. The control measures are the same as for the other species.

The twelve- spotted asparagus beetle

Rust

Rust is a common and destructive disease of asparagus. The bushy top of the host becomes covered with reddish or black pustules.

This prevents the normal manufacture of food and its storage in the roots, thus decreasing the succeeding season's yield. All affected tops should be burned late in the fall. During the cutting season all plants should be kept cut. The United States Department of Agriculture has developed the Martha

Washington and Mary Washington strains of asparagus, which are practically immune from rust, and growers planting new beds in localities where the disease is destructive should obtain these strains. They can be procured from seed companies that handle asparagus. ■

ASTER

Wilt

The most conspicuous symptom of the wilt disease of aster is the sudden death of the plant. The stem is blackened and decayed at the ground line. The leaves on one side of the plant, especially the lower leaves, are yellowed and wilted, and the youngest leaves are smaller than normal. Plants started in flats are more frequently affected than those started in the open. Seed should be treated, sown thinly in clean or sterilized soil in the seedbed, and set in soil in which no diseased plants have been grown. Asters should not be grown in the same soil year after year. For seed treatment, the seed should be soaked in water for thirty minutes at a temperature of 90° to 100° F., then soaked in 1-1000 corrosive sublimate for thirty minutes at the same temperature, and then washed in running water for five to ten minutes. It should be dried at once, but artificial heat should not be used.

Yellows

At present the most destructive disease of asters is yellows, which stunts and bleaches the plant so that blossoms are not produced. The disease is caused by a virus which incubates within the body of a leaf hopper for a certain number of days before it can cause infection. The leaf hopper then inoculates the healthy plant when it feeds. The only means of control, therefore, is barring the leaf hoppers from the aster bed. This may be done by inclosing the bed completely in a cheesecloth (or tobacco-cloth) tent. Care must be taken in making the tent to leave no holes of any kind, and the door must be kept securely closed. If any plants become diseased under the cloth, they should be rogued at once. Asters grown near a house or other buildings usually are free from yellows because leaf hoppers seem to avoid such close proximity to human habitation.

BARLEY

Smuts

There are two common smuts of barley, each causing about the same amount of damage in New York. The loose smut causes the barley heads to blacken. This charred mass is made up of fungus spores, which blow away to infect other plants and leave the rachis bare. The covered smut may be distinguished by its retaining more of the outer hulls of the head, so that the black spore mass is held partly in place by the withered and whitened glumes. Directions for seed treatment to control loose smut of wheat and barley are given on page 53. This treatment will control both kinds of smut on barley; but when covered smut alone is to be combated, the barley seed may be treated in the same way as are oats for oat smut (page 31). Good results in the control of loose smut on the six-rowed varieties of barley have been obtained by the use of formaldehyde. Ceresan also has given good results in the control of covered smut on all barley varieties, and at least partial control of loose smut on the six-rowed varieties. It does not reduce the percentage of germination, as formaldehyde sometimes does.

BEAN

**Mexican
bean-beetle**

The hemispherical, yellow, black-spotted Mexican bean-beetles attack the bean plants soon after they have appeared aboveground, and eat holes in the foliage from the underside. They lay clusters of yellowish eggs which hatch into oval, yellowish larvae covered with black-tipped spines which give them a fuzzy appearance. The larvae feed on the underside of the leaves, devouring all except the thin upper epidermis and a lace-like network of veins. This pest is controlled by spraying with $1\frac{1}{2}$ pounds of calcium arsenate and 3 pounds of hydrated lime in 100 gallons of water. The spray should be applied with a 90°-angle nozzle so that it will cover the underside of the leaves, where the larvae feed. Spraying should be begun when the injury first appears, and should be repeated at intervals of ten days to two weeks until the pods form.

**Seed-corn
maggot**

In wet seasons many stands of beans are ruined by the seed-corn maggot. The parent fly lays its eggs in moist soil in the spring, and the maggots destroy the buds of the developing bean shoots before they appear aboveground, causing deformed plants known as *snakeheads*. Snakeheads never develop into thrifty plants, and do not mature pods. Fitting the land early, delaying planting until the soil has warmed and dried somewhat, and planting the seed shallow, will, to a considerable extent, enable the plants to escape injury. Beans should not be planted in wet, heavy soil.

**Anthracnose,
or pod spot
(Figure 14)**

Anthracnose, or pod spot, is a fungous disease of the bean, commonly known among growers as *rust*. It causes black, sunken cankers on pods and stems, and kills the veins on the lower side of the leaves. The cankers have a characteristic salmon-colored, gelatin-like material oozing from the center during wet weather. The disease is favored by much moisture and a fairly low temperature. It ceases to spread when the temperature rises above 80° F. Two precautions in the control of the disease are well-drained soil and rotations with other crops. The principal recommendation, however, is the obtaining of healthy seed or of seed that is resistant to the disease. In Idaho, snap-bean seed is grown which is free from anthracnose but has an extremely large amount of mosaic; therefore the only way to be sure of healthy snap-bean seed is to select healthy ripened pods. Hodson's wax beans are somewhat resistant, but their quality is not of the best. Better varieties and strains are being bred and selected at the New York State College of Agriculture at the present time. Spraying with bordeaux mixture, 4-4-50, may be beneficial in some years, in the case of snap beans. Very desirable resistant varieties of field beans are now available for planting. Among these are Michigan Robust Pea, Wells' Red Kidney, Perry Marrow, Nova Scotia Marrow, and Yellow Eye. The Red Kidney seed obtained from the Sacramento Valley in California is free from anthracnose and is used rather generally in this State.



FIGURE 14.
BEAN
ANTHRACNOSE

Blight

Blight is caused by any one of six species or varieties of bacteria. These kill large areas of the leaf, produce water-soaked lesions with reddish margins on the pods, cause a yellowish discoloration of the seed, and may girdle stems so that affected plants later wilt or fall over and die. Some of the blight bacteria grow best at a high temperature when there are heavy dews or drizzling rains, while others require fairly cool weather. On very susceptible varieties, as Red Kidney and White Kidney, blight is the most difficult to control of all the bean diseases. Pea beans are fairly resistant, and Marrows are slightly more so than Kidneys. Most of the snap beans are susceptible. Red Kidney beans obtained from the Sacramento Valley in California are free from blight and are used rather generally. Snap beans from Idaho also have no blight, but they have too much mosaic for use as seed. The picking of healthy pods, as recommended for controlling anthracnose, is of no value in the control of blight. An earnest attempt should be made to locate bean fields where the disease is not present, as a source of seed. If the grower has a seed plot, all blighted plants should be removed and burned. Bean straw from infected fields should not be returned to bean lands in manure. Late planting sometimes proves beneficial, although this practice cannot always be relied upon.

Dry root rot

Dry root rot affects the part of the stem at and below the surface of the ground, causing affected areas to become reddish and to shrivel. This results in vines of low vigor and yield. No satisfactory method of control has been worked out. However, a few precautions may be observed: (1) land on which beans have never or seldom been grown should be used for planting; (2) manure containing bean straw should not be applied to bean fields; (3) shallow cultivation and rotations of at least six years should be practiced. Soil with enough plant food to cause vigorous growth of the bean plants also is very desirable.

Mosaic

Mosaic may be most readily recognized by the appearance of the young leaves. They are cupped downward; the smaller veins are not evident on the upper side; there are cupped warts or swellings on the upper side, which are usually deep green in color; and the whole leaf, especially when held to the light, shows dark and light green areas forming a mosaic pattern. The whole plant is likely to be paler green—commonly spoken of as “off color”—and rarely bears productive pods. Mosaic cannot be controlled by the selection of seed from disease-free plants, at least not in fields where the disease is at all common. The resistant Robust Pea may be used in place of other pea beans. The Marrow and the Yellow Eye are nearly free from mosaic, and the Red Kidney seems to tolerate it fairly well. Selections are being made with snap beans, and resistant strains will be available later. Western seed of susceptible varieties, particularly from Idaho, may contain a considerable percentage of this disease.

BEETS**Leaf spot**

Leaf spot is a fungous disease of beets which shows as dead spots on the foliage. It is seldom destructive, and can be controlled by spraying with bordeaux mixture at intervals of about two weeks.

Scab

The scab disease of beets is the same as the scab disease of potatoes, and is likely to occur where beets are grown following a scabby crop of potatoes or beets. Control measures are the same as for potato scab—rotation of crops, and leaving the soil unlimed.

BLACKBERRY

(See *Raspberry*, page 44)

BRUSSELS SPROUTS

(See *Cabbage, Cauliflower, and Brussels Sprouts*, below)

CABBAGE, CAULIFLOWER, AND BRUSSELS SPROUTS

Cabbage aphids Cabbage aphids are small, mealy, plant lice which are especially troublesome during cool, dry seasons, when their natural enemies are less active. They are best controlled, even on large areas, by 2- or 3-per-cent-nicotine-lime dust applied with a hand duster. Frequent examination of the fields and immediate treatment of infested plants will often prevent a general infestation.

**Cabbage
root-maggot
(Figure 15)**

The white cabbage root-maggots hatch from eggs laid by a small fly (which somewhat resembles the common house fly) on the surface of the ground near the plant. Early cabbage plants in the field may be protected from maggot attack by treatment with corrosive sublimate. This material, in powder form, is dissolved in

water at the rate of 1 ounce in 10 gallons (for cauliflower, 1 ounce in 12 to 15 gallons). It is best to first dissolve the corrosive sublimate in a gallon of hot water and then dilute to the required amount. About a teacupful is poured around the stem of each plant so as to wet the soil thoroughly. About 20 gallons of the solution is needed for 1000

plants. The first application should be made as soon as the plants are set out in the field, and two later applications should be made at intervals of a week.

Late cabbage seldom requires protection from maggot attack after it has been planted in the field, but protection is needed in the seedbed. Two methods are commonly used: (1) Corrosive sublimate may be applied, at the dilution suggested for field treatment; it should be used at the rate of 1 gallon for 20 to 40 feet of row depending on the age of the plants, starting when the plants are three to five days old and making three applications at intervals of ten days. (2) The bed may



FIGURE 15. CABBAGE ROOT-MAGGOTS

be surrounded with boards from 6 to 8 inches wide, placed on edge and covered tightly with a screen of cheesecloth as soon as the plants begin to appear; in order to harden the plants, the cloth should be removed ten days before they are ready to be transplanted.

Cabbage worm

The green caterpillars of the cabbage worm hatch from eggs laid by the common white butterfly. There are several broods every season. The best method of control consists in dusting the plants with a mixture of 1 part of lead arsenate and 8 parts of hydrated lime. Applications should be made at intervals of ten days to two weeks from the time when the plants are set in the field until they are cut. Spraying with 2 pounds of lead arsenate and 2 pounds of soap to 50 gallons of water also is effective.

Blackleg

The blackleg disease is caused by a fungus which can live both on and in the seed and in the soil. The stems of affected plants are destroyed at or near the surface of the soil by dry rot, and the plants die slowly, succumbing during any stage of growth but usually not previous to transplanting. Control methods are the same as for black rot, except that in addition the seed should be treated for thirty minutes in water heated to 122° F. This treatment will injure old, weak seed, and therefore should be practiced with caution. Growers on Long Island are fortunate in having the treating tanks supplied by the cauliflower association and operated by the farm bureau.

Black rot

In the bacterial disease known as *black rot*, or *blight*, the bacteria get into the sap tubes of the leaves, clogging them and turning them black. The plants drop their leaves and fail to head. In controlling this disease, the following measures should be given consideration: (1) A three- or four-years crop rotation should be practiced, and the grower should bear in mind that rape, kale, turnips, wild mustard, and other cruciferous plants also are susceptible. (2) Too much emphasis cannot be placed upon having disease-free soil for the seedbed. (3) The use of contaminated manure and diseased cabbage refuse should be guarded against. (4) An attempt should be made to obtain seed from disease-free crops; the seed grower will produce healthy stock if the demand for such seed is strong enough. (5) All seed of cabbage and cauliflower should be treated with corrosive sublimate, one tablet dissolved in each pint of water used; the seed, tied loosely in cheesecloth bags, should be placed in the solution for twenty minutes; after removal, the seed should be rinsed in clean well or spring water, and then dried; the drying should never be done over a hot stove or in direct sunlight.

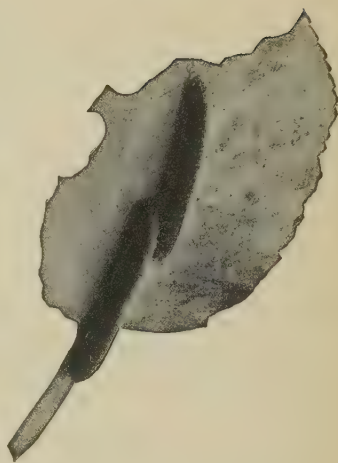


FIGURE 16. IMPORTED CABBAGE WORMS

**Clubroot,
or clubfoot
(Figure 17)**

In clubroot, unsightly swellings occur on the roots of cabbage, cauliflower, turnip, radish, shepherd's-purse, wild mustard, and other related plants. The causal parasite lives in acid soil. The disease is best controlled by: (1) locating the seedbed in soil in which cabbage has never been grown; (2) liming the field heavily with hydrated lime six to eight weeks before the cabbage is set in the field; (3) boiling diseased roots before feeding them to stock; (4) cultivating thoroughly, destroying all weeds of the mustard family; (5) setting healthy plants; (6) practicing a rotation of crops; and (7) use of corrosive sublimate as for wire stem.

**Damping-off
and wire stem**

The diseases known as *damping-off* and *wire stem* either kill the young plant or cause injury to the base of the stem so that the plant never completely recovers. Most of the injury is found in the seedbed, although wire stem may be common in the field. The best control measure is the application of corrosive sublimate, 1 ounce in 10 to 15 gallons of water, to the plants in the seedbed once a week for three to five weeks, beginning as soon as the plants are up. One gallon of the solution will cover 20 to 40 feet of row, depending on the size of the plants.



FIGURE 17. CLUBROOT OF CABBAGE

CARNATION

Red spider mite — See under *Greenhouse Insects* (page 30).

Alternariose

Alternariose spots occur mostly on the leaves of carnations, but they are found frequently on the stems, especially at the nodes. Death of the parts above a stem lesion may result. The spots are light gray in color, dry, somewhat sunken, and from approximately circular to elongate. A black fungous growth occupies the center of the lesion. Watering, syringing, and ventilation should be so regulated as to keep the foliage as dry as possible and avoid a humid atmosphere. Diseased plants and plant parts should be removed and burned. Seriously diseased varieties may have to be discontinued, at least temporarily.

Bacterial spot

Bacterial spot is a disease in which circular spots, with slightly brown centers and a narrow, water-soaked border which persists as the spots enlarge, are produced on leaves and stems. The older spots resemble leaf spot. Leaves that are severely diseased soon wither. The plants become infected in the field. The foliage should be kept as dry as possible, and maximum ventilation should be provided.

Fusarium stem rot**Leaf spot****Rhizoctonia stem rot**

Fusarium stem rot is a dry rot of the lower part of the carnation stem. Plants affected by this disease die slowly, usually a branch at a time. The treatment is the same as for Rhizoctonia stem rot. Round, grayish spots on stems and leaves are evidences of the presence of leaf spot. The treatment is the same as for rust. The cause of Rhizoctonia stem rot is a soil fungus. The plants wilt suddenly, the stem being affected with soft rot at or below the surface of the soil. In the field the location of the plants should be changed frequently, annually if possible. In the benches, sterilized soil, or at least fresh soil, should be used. After transplanting into the greenhouse, the temperature should be kept as low as possible until the plants have become established. The soil should be stirred frequently. Overwatering should be guarded against.

Rust

Rust can be recognized by the brown, powdery pustules on stems and leaves. Only the varieties least affected by this disease should be planted, and only cuttings from healthy plants should be taken. The plants should be dusted with sulfur often enough to keep a thin coating of dust on them throughout their growth. In the field the plants should be dusted before rains; and for plants in the house, when the protective coating is removed by syringing it should be restored immediately. Special prepared dusting sulfur should be used, applied with a duster. The greenhouse air should be kept as dry and as cool as is compatible with good growth. The foliage should be kept free from moisture in so far as is practicable, and the plants should be trained so as to secure a free circulation of air around each.

CARROT**Carrot rust fly**

The carrot rust fly is the one serious insect pest of carrots in most parts of New York. It attacks celery and parsnips also. The maggots of this tiny fly live in the soil and riddle the plant roots with rusty-colored burrows. In severe infestations the roots of the plants decay and the tops die. There are two main broods of the insect each year, the first attacking early plantings and the larger second brood injuring the main or late plantings. Where practicable, the complete elimination of all early plantings of carrots, celery, and parsnips in a locality where the main crop of carrots is planted after the first of June, should insure comparative freedom from injury. Where this is impracticable, the main crop can be kept clean by planting after the first of June and harvesting by the first or the middle of September. In the home garden the growing plants may be treated with a suspension of mercurous chloride, 3 ounces to 10 gallons of water, applied about the base of the plants at the rate of 1 gallon to 30 or 40 feet of row. From two to four applications should be made for each brood.

Leaf blight

At least two fungi are common on carrot leaves and stems which cause them to turn brown and die. Spraying with bordeaux mixture or dusting with copper-lime dust, at frequent intervals during the rapidly growing period, will aid in the production of a healthy crop. The destruction of diseased-carrot refuse, and the rotation of crops, also are beneficial.

Rot

Stored carrots are often destroyed by a soft rot, which attacks other vegetables also. This rot can usually be distinguished from other rots by the presence of white, fluffy mold, and hard black bodies $\frac{1}{4}$ inch or more in diameter. The disease can be eliminated from a field by a sufficiently thorough removal and destruction of all affected vegetables in each

crop so that none of the fungous resting bodies get into the soil. Carrots that are to be stored should not be grown in fields where the preceding crops have suffered from the rot. They should be stored under as dry and cool conditions as possible, in sand, leaves, or straw.

CAULIFLOWER

(See *Cabbage, Cauliflower, and Brussels Sprouts*, page 17)

CELERY

Rust fly — See under *Carrot* (page 20).

There are three known kinds of leaf blight of celery: early, or **Leaf blights** *Cercospora*, blight; late, or *Septoria*, blight; and bacterial blight. All three are first apparent as more or less isolated dead spots on the leaves, and these spots may increase sufficiently in size and number to kill the foliage. Late blight affects the stems also. The same treatment is recommended for the three blights. The most important measure is dusting the seedbed from three to five times. The plants should be sprayed with bordeaux mixture or dusted with copper-lime soon after being transplanted, and the applications should be repeated every week during the growing season. When blight is severe, two applications should be made in the first week of spraying.

Pink rot Pink rot is sometimes very destructive to celery in the storage trenches. This is the same disease as the storage rot of carrots, and is recognized by the white mold and the hard, black, fungous bodies. The disease can be eliminated from a field by a sufficiently diligent removal and destruction of all rotted plants. Crop rotation is of value. Celery trenches should have as much air circulation as possible, for heat and moisture favor the development of the rot. The temperature during storage should be about 31° F.

CHERRY

Black cherry aphid Early in the season the black cherry aphids, which are dark brown in color, curl the terminal leaves of cherry trees and smut the fruit, especially attacking sweet cherries. They can be controlled by a thorough application of nicotine sulfate, 1 pint in 100 gallons of spray, just before blossoming (see spray schedule, page 22). Later sprays are ineffective against this pest.

Cherry maggot Cherry fruit-flies are small flies with banded wings, which insert their eggs under the skin of the fruit. The maggots burrow in the flesh. The flies can be poisoned before they lay their eggs, by applications of lead arsenate, 2½ pounds to 100 gallons of spray, according to the schedule on page 22. It is essential to spray at the same time all interplanted trees and the first three or four rows of adjoining orchards.

Curculio — See under *Plum* (page 38).

Black knot Black knot, although somewhat less common on cherries, is the same disease as occurs on plums. (See *Black knot of Plums*, page 38, for control measures.)

Brown rot Brown rot of cherries is produced by the same fungus that causes the brown rot of peaches and plums (pages 34, 38). Spraying should be done according to the schedule on page 22.

SOUR-CHERRY SPRAY SCHEDULE

Time of application	Spray mixtures	Enemy	Dust mixtures
Just before blossoms open	Lime-sulfur, $2\frac{1}{2}$ gals. Water to make 100 gals.	Brown rot Blossom blight	Dusting sulfur
When petals fall	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, $2\frac{1}{2}$ lbs.* Water to make 100 gals.	Leaf spot Brown rot Curculio	90-10 sulfur-lead-arsenate dust, or if curculio is abundant 80-20 sulfur-lead-arsenate dust
Ten days after petals have fallen or when shucks are off	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, $2\frac{1}{2}$ lbs.* Water to make 100 gals.	Brown rot Leaf spot Curculio	90-10 sulfur-lead-arsenate dust, or if curculio is abundant 80-20 sulfur-lead-arsenate dust
For all varieties when Early Richmond cherries first show a tinge of red	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, $2\frac{1}{2}$ lbs.* Water to make 100 gals.	Maggot Leaf spot Brown rot	90-10 sulfur-lead-arsenate dust. If rains are of frequent occurrence, apply a dust about one week after the application made when Early Richmond cherries show red on one side. Then about a week later apply another dust
For all varieties when Montmorency cherries first show a tinge of red	Lime-sulfur, $2\frac{1}{2}$ gals. Lead arsenate, $2\frac{1}{2}$ lbs.* Water to make 100 gals.	Maggot Leaf spot Brown rot	
After picking	Lime-sulfur, $2\frac{1}{2}$ gals. Water to make 100 gals.	Leaf spot	Dusting sulfur

SWEET-CHERRY SPRAY SCHEDULE

Time of application	Spray mixtures	Enemy
Pre-blossom	Lime-sulfur, 11 gals. Nicotine sulfate, 1 pt. Water to make 100 gals.	Scale Brown rot Aphis
When bud scales separate and expose green blossom buds	or Nicotine sulfate, 1 pt. Soap, 3 to 5 lbs. Water to make 100 gals.	Aphis

For all later applications follow the sour-cherry schedule, substituting 2 gallons for $2\frac{1}{2}$ gallons of lime-sulfur in the spray mixture

* The amount of lead arsenate is given for powder form; if paste form is used, twice as much is required

Leaf spot Leaf spot is a fungous disease in which the leaves are covered with numerous reddish or brown spots and fall prematurely. Badly affected trees winterkill. Often the dead spots drop out, leaving clear-cut holes. Spraying should be done according to the schedule on page 22.

Powdery mildew Powdery mildew attacks the leaves at the tips of growing shoots, and is often serious on nursery stock. The leaves curl and show the white, mealy growth of the fungus. The trees should be dusted heavily with sulfur or sprayed with lime-sulfur solution, 1 to 50.

CHRYSANTHEMUM

Red spider mite— See under *Greenhouse Insects* (page 30).

Rust For rust of chrysanthemum, the plants should be dusted with dusting sulfur. (The foliage should be kept covered with a thin coating throughout the life of the plants.) Care should be taken not to wet the foliage when watering the plants, and to syringe the plants in the morning on a rising temperature.

Septoria leaf spot Septoria leaf spot is a fungous disease. The plants should be sprayed with bordeaux, 5-5-50, every ten days or often enough to protect new foliage. Ammoniacal copper carbonate may be used, but it is not so effective.

CORN

Smut The familiar smut masses occur on corn wherever it is grown, and often result in noticeable losses. The spores of the causal fungus remain in the soil over winter or are brought in with manure when infected corn is fed. The fungus is killed in the silo. Crop rotation and the use of uninfested manure reduce the disease. The grower should go through the corn fields several times each year, and cut out and burn or bury the smut masses before they burst open. If this practice is followed yearly, it will result in continued diminution of smut.

CUCUMBER, MELON, AND SQUASH

Aphis Dark green plant lice feed on the under side of the leaves of cucumber, melon, and squash, causing them to curl and wither. Infested vines should be dusted as soon as the plant lice appear, with 3-per-cent-nicotine-lime dust on a still, warm day. Spraying with nicotine sulfate, 1 pint in 100 gallons of water, with 3 to 5 pounds of soap added, also is fairly effective if applied with an angle nozzle so as to cover the under side of the leaves where the aphids feed.

Squash stinkbug The rusty brown, adult squash stinkbugs attack the plants as soon as they are through the ground, and sometimes kill them outright. The young bugs feed on the under surface of the leaves, causing them to wilt and die. The clusters of shining, brownish eggs on the under surface of the leaves should be destroyed whenever found. The nymphs can be killed by spraying with nicotine sulfate as used against the aphis, or by pyrethrum-soap sprays.

Squash-vine borer

Many squash vines are killed by a white caterpillar which burrows in the stem near the base of the plant. Spraying the stems and base of the plants with nicotine sulfate, 1 ounce to 3½ gallons of water, making several applications at weekly intervals beginning about the time when the vines begin to run, will kill most of the eggs and reduce the infestation. The stems of infested plants should be slit and the borer killed with the knife. When the vines are long enough they should be covered at the joints with earth, in order to develop secondary root systems for the plant in case the main stem is injured. As soon as the crop is harvested, the vines should be removed and destroyed.

Striped cucumber beetle

The yellow, black-striped cucumber beetles may appear in numbers and attack the plants as soon as they are through the ground. Many of the beetles can be killed by dusting with a 3- or 4-per-cent-nicotine-lime dust on warm days. This may be applied by means of a hand-operated duster. The best results are obtained when the discharge hose is equipped with a metal or canvas cone to confine the nicotine fumes around the plant for a few seconds. The young plants can be protected also by dusting them evenly with a mixture of one part of calcium arsenate and 15 parts of gypsum. The beetles injure older plants chiefly by spreading the germs of bacterial wilt. (For seasonal control of this and other diseases, see *Suggested Cucumber Spray Schedule*, page 25.)

Downy mildew

Downy mildew, a serious fungous disease of the cucumber, is known among growers as *blight*. The leaves become mottled with yellow, show dead spots, and then dry up. The vines should be sprayed with bordeaux mixture, 4-4-50, to which is added 2 to 3 pounds of calcium arsenate, the first application being made when the plants begin to run, and later applications being made every ten to fourteen days throughout the season.

Leaf and fruit spots

There are several distinct leaf and fruit spots, of both cucumbers and melons, which can be controlled by spraying as for downy mildew, except that the applications should be started when the first leaves appear and continued each week until the fruit sets.

Mosaic, or white pickle

Mosaic, or white-pickle disease, is proving very troublesome. The fruits on plants affected with this disease are light-colored or mottled with yellow and green, the green blotches often standing out as warts. The leaves are yellowish or mottled, or are stunted, and the plants die prematurely. The disease is transferred readily from diseased to healthy plants by the common cucumber aphids and beetles, by workmen in handling the plants, and through contact between healthy and diseased plants. In greenhouses, the removal of diseased plants and the destruction of insects by fumigation keep the disease under control. In the field, the following precautions are suggested: (1) removal of early diseased plants as soon as found; (2) control of cucumber insects; (3) destruction of such weeds as milkweed, the wild and bur cucumbers, catnip, pokeberry, and ground cherry, which are the hosts that not only help disseminate the virus but also serve as a place for it to winter over, thus becoming centers of infection the next spring. In small gardens, the practice of caging the plants to keep insects away may be desirable.

Wilt

Wilt is a disease caused by bacteria that get into the sap tubes of the leaf and the stem and clog and destroy them, causing the plant to wilt. The bacteria are distributed chiefly by striped cucumber beetles. Methods of control are difficult, but the following precautions

should be taken: (1) spray applications should be made carefully with bordeaux mixture and calcium arsenate, or copper-lime dust with calcium arsenate, as soon as the plants are through the ground and often enough thereafter to keep them covered (see also *Suggested Cucumber Spray Schedule*, below); (2) diseased plants should be pulled promptly and burned or buried, (3) a few garden plants may be protected with closely woven cheesecloth covering a frame made by cutting a barrel hoop in halves and placing these halves at right angles to each other.

SUGGESTED CUCUMBER SPRAY SCHEDULE

For the first week protect the plants with calcium arsenate and gypsum dust or with nicotine-lime dust (see page 50)

Time of application	Spray mixture	Enemy	Dust mixture
Begin when the plants are a week old, and repeat at intervals of four to eight days	Bordeaux mixture, 4-4-50* Calcium arsenate, 2 lbs.	Cucumber beetle Wilt Angular leaf spot Mildew Scab	20-25-55 Copper sulfate, calcium arsenate, hydrated lime

* This schedule applies to muskmelons also, except that bordeaux mixture 3-6-50 should be used for that crop.

CURRANT

Currant worm
(Figure 18)

of lime-sulfur, 1 to 40 (see *Leaf spot*, page 26). If a second brood appears after the fruit is half grown, hellebore should be used.

Cane blight, or wilt

Cane blight, or wilt, is very destructive to currants in the Hudson Valley. The canes die suddenly while loaded with fruit and leaves, as do those attacked by the cane borer. The disease is caused by a fungus which kills the bark in places and discolors the wood. No definite line of treatment has been established, but a good practice is to examine the plantation three

or four times every summer, beginning when the plants are small, and cut out and burn all canes showing signs of disease.



FIGURE 18. CURRANT WORMS

Leaf spot and anthracnose

(Figure 19)

Leaf spot and anthracnose are caused by two or three different fungi. The leaves become spotted, turn yellow, and fall

prematurely. These diseases may be controlled by three to five sprayings with bordeaux mixture, 5-5-50, or lime-sulfur, 1-50. An application after picking is completed will help to keep the foliage from dropping. On the first appearance of currant worms, the bushes should be sprayed with bordeaux mixture and lead arsenate, 4 pounds of lead arsenate to 100 gallons of bordeaux mixture. Ninety parts of finely ground sulfur and ten parts of dry lead arsenate, applied as a dust, has proved equally successful. If a second brood of worms appears, the application should be repeated.

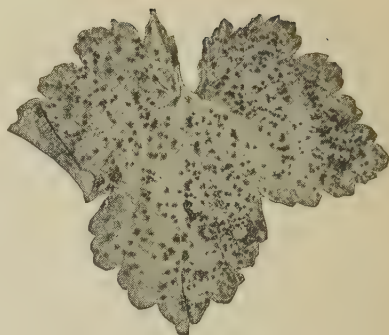


FIGURE 19. CURRANT LEAF SPOT

GOOSEBERRY

Powdery mildew

The fruit and leaves of gooseberry bushes attacked by powdery mildew are covered with a dirty-white growth of fungus. The disease is severe on European varieties. In setting a new plantation, a site should be chosen where the land is well underdrained and where there is a good circulation of air. Drooping branches should be cut away. The ground underneath should be kept free from weeds. When the first evidence of mildew appears, the bushes should be sprayed thoroughly with lime-sulfur solution (32° Baumé) diluted 1 to 40, and the spraying should be repeated as often as necessary. Ninety parts of finely ground sulfur and ten parts of dry lead arsenate, applied as a dust, has proved equally successful. From one to five applications may be required.

GRAPE

Flea beetle, or steely beetle

The small, shining blue flea beetles appear in early spring and eat into the opening buds of grapes. The beetles should be hand-picked into a pan containing a little kerosene. The brown larvae eat ragged holes in the leaves between May 15 and June 1, and can be killed by spraying with lead arsenate, 3 pounds in 100 gallons of bordeaux (see *Black rot*).

Leaf hopper

The small yellowish leaf hoppers, incorrectly called *thrips*, suck the sap from the under side of the grape leaves, causing them to turn brown and dry up. In vineyards where leaf hoppers are a serious pest, the foliage should be thoroughly sprayed on the under side with nicotine sulfate, 1 pint in 100 gallons of bordeaux, about July 12.



FIGURE 20. GRAPE ROOTWORM

Rootworm**(Figure 20)**

The small white grubs of the rootworm feed on the roots, usually killing the vines in a few years. The adults are small, grayish brown beetles, which eat peculiar chain-like holes in the leaves during July and August. Thorough cultivation close to the vines during June will kill many of the pupae in the soil.

Rose chafer

The ungainly, long-legged, grayish rose chafers are found in sandy regions and often swarm into vineyards and destroy the blossoms and the foliage of grapes. The vines should be sprayed thoroughly with arsenate of lead, 5 pounds in 100 gallons of water sweetened with 2 gallons of molasses or 25 pounds of confectioner's glucose.

Black rot

Black rot has been the most destructive fungous disease of grapes in this State. It is carried over from one season to the next chiefly in old, rotted berries or mummied fruits that fall to the ground or cling to the vine. All mummies that cling to the canes at trimming time should be removed. The soil should be plowed early, all mummies and diseased leaves being turned under. All refuse should be raked under the vines and covered, using the grape hoe. This work cannot be done too thoroughly. The vines should be sprayed four times with bordeaux mixture, 4-4-50: first, when the shoots are ten inches long; second, just as soon as the blossoming period is over; third, when the berries are of the size of peas; fourth, from two to three weeks later. Infections take place with each rain throughout the growing season. The foliage should be protected by a coating of the spray before every rain. The new growth, especially, should be well sprayed. When the foliage becomes dense, the clusters should be sprayed with a trailer, or hand-spraying device. (For use of insecticides in bordeaux mixture, see under *Flea beetle*.)

Dead arm

The arms, trunks, green shoots, petioles, leaf veins, and fruits of grapevines are affected by dead arm. In June or early July the leaves show a peculiar yellowing, dwarfing, and curling. As the name indicates, the disease exhibits itself chiefly through the death of the arms. In many cases, however, the whole vine dies, and usually suckers then grow up at the base. The affected vines may die at any time, but the majority die in the winter. All the affected vines should be marked during the summer and removed at pruning time. Care should be taken not to disseminate the fungus in using the pruning tools. Spraying as for black rot will protect the vines from new infections.

Downy mildew

Downy mildew is a fungous disease most evident on the leaves, making large brown spots on the upper surface, with a white, downy growth beneath. It also attacks the green fruit, causing what is known to growers as *hard white berry*. In most years, downy mildew is limited to the Finger Lakes region. The most effective control measure is a spray of 4-4-50 bordeaux mixture just before bloom. A second spray should be applied as soon as the blossoms are set. In the Keuka Lake section, a third application, and in some seasons a fourth, is necessary.

Powdery mildew

A white, powdery, talcum-like mold attacks any part of the plant that is green, as leaves, canes, flowers, and fruit. Sulfur is the best fungicide to use, but because of its injurious effect it can be applied only to vines of European origin. Two applications of 4-4-50 bordeaux mixture will usually control powdery mildew. The first spray should be applied as the berries begin to touch in the cluster, and the second about two weeks later. A third spray three weeks later may be required in the Niagara district. For the early applications the addition of 3 pounds of resin-fish-oil soap to each 100 gallons of spray gives a more uniform spread, and less spray mixture is then required. Spreaders should not be used in late-season applications because of the spray residue.

GRAPE SPRAY SCHEDULE
(For the Hudson River Valley)

Time of application	Spray mixtures	Enemy
Just before blossoms open	Bordeaux mixture, 4-4-50	Black rot Downy mildew
As soon as berries set	Bordeaux mixture, 4-4-50	Black rot Downy mildew
When berries begin to touch in cluster	Bordeaux mixture, 4-4-50	Black rot Downy mildew Powdery mildew
Special leaf-hopper spray. When the maximum number of leaf-hopper nymphs are present. Usually this spray can be combined with the preceding. (See note)	Bordeaux mixture, 4-4-50 Nicotine sulfate, $\frac{1}{4}$ pt. Resin-fish-oil soap, $1\frac{1}{2}$ lbs.	Grape leaf-hopper
Two weeks later	Bordeaux mixture, 4-4-50	Black rot Downy mildew Powdery mildew
Special rose-chafer spray, to be applied as soon as beetles appear	Confectioner's glucose, 25 lbs., or cheap molasses, 2 gals. Lead arsenate, 5 lbs. Water to make 100 gals.	Rose chafer

Further applications to be determined by weather conditions and previous control of the mildews and black rot.

If black rot has been severe in past years, an early application should be made when the second and the third leaf are showing, using bordeaux mixture, 4-4-50. If frequent rains of long duration occur shortly before the blossoms open, the pre-blossom spray is advised for both black rot and downy mildew.

If downy mildew has been severe, the pre-blossom spray should be made regardless of weather conditions prevailing. If downy mildew and black rot are rarely important, the pre-blossom spray may be omitted.

For leaf hoppers, the application should be made soon after July 4, when the newly hatched nymphs are on the leaves. An upturned nozzle must be used, and care must be taken to hit the insects. Spraying with fixed nozzles will do practically no good. Unless the leaf hoppers are extremely abundant, a special spray for this insect is not likely to be profitable.

GRAPE SPRAY SCHEDULE
(For the Finger Lakes region)

Time of application	Spray mixtures	Enemy
About one week before the blossoms open. (See note)	Bordeaux mixture, 4-4-50 If larvae of flea beetle are present, add lead arsenate, 1½ lbs.*	Black rot Mildew Flea beetle
As soon as the berries set	Bordeaux mixture, 4-4-50	Black rot Mildew
Two weeks later. Subsequent applications if necessary. To be determined by weather conditions and previous control of black rot and mildew	Bordeaux mixture, 4-4-50	Black rot Mildew

If black rot has been severe in past years, an early application should be made when the second or the third leaf is showing, using bordeaux mixture, 4-4-50.

Grape leaf-hopper may be controlled by very thorough spraying, using the following formula: bordeaux mixture, 4-4-50; nicotine sulfate, ¼ pint in 50 gallons of the mixture. The application should be made soon after July 4, when the newly hatched nymphs are on the leaves. An upturned nozzle must be used, and care must be taken to hit the insects. Spraying with fixed nozzles will do practically no good. Unless the leaf hoppers are extremely abundant, a special spray for this insect is not likely to be profitable.

GRAPE SPRAY SCHEDULE
(For the Chautauqua grape region)

Time of application	Spray mixtures	Enemy
Special berry-moth spray Just as soon as fruit has set Special effort should be made to place the spray on the clusters This is a special berry-moth spray and can be omitted if the pest is not present	Bordeaux mixture, 4-4-50 Lead arsenate, 1½ lbs.* Resin-fish-oil soap, 1½ lbs.	Berry moth
When the rootworm beetles first appear in numbers, usually from a week to ten days after fruit has set	Same as above	Rootworm Berry moth Powdery mildew
Ten days to two weeks later	Same as above	Root worm Berry moth Powdery mildew
Special leaf-hopper spray When the maximum number of leaf-hopper nymphs are present, usually between July 12 and 20 During certain seasons this spray can be combined with the preceding	Bordeaux mixture, 4-4-50 Nicotine sulfate, ¼ pt. Resin-fish-oil soap, 1½ lbs.	Leaf hopper
Special rose-chafer spray, to be applied whenever the beetles appear	Confectioner's glucose, 25 lbs., or cheap molasses, 2 gals. Lead arsenate, 5 lbs. Water to make 100 gals.	Rose chafer

* The amount of lead arsenate is given for powder form; if paste form is used, twice as much is required.

GREENHOUSE INSECTS

Green aphid

Plant lice on greenhouse plants can be controlled by spraying with free nicotine, 1 pint to 100 gallons of water, by fumigating with nicotine, or by fumigating with calcium cyanide. (Directions for fumigating are given on page 55.) If violets are infested, the greenhouse should be fumigated, from $\frac{1}{2}$ to $\frac{3}{4}$ ounce of sodium cyanide for each 1000 cubic feet of space being used. The fumigation should continue for one-half to one hour.

Red spider mite

The small red spider mites puncture the plant tissue and suck out the juices, causing the leaves to become brown and dry and reducing the number and size of the blooms. The mites can be held in check by frequent syringing with water at high pressure, the spray being directed at the lower surface of the leaves from below. To avoid danger of leaf spot and other fungous troubles, the syringing should be done on sunny days when the plants will dry quickly. Dusting with fine dusting sulfur also is fairly effective.

White fly

The nymphs of the white fly are small, greenish, scale-like insects, found on the under side of leaves; the adults are minute, white, mealy, winged flies. Plants infested should be sprayed with nicotine solution (page 49), or fumigated with calcium cyanide as described on page 55.

HOLLYHOCK

Rust

Rust of hollyhock is easily recognized by its yellow to brown pustules on the lower side of the leaves and on the stems. Badly rusted leaves wither and die as though blighted. Spraying has not been found to be effective, although dusting with finely ground sulfur offers some promise. Rigid early inspection, with destruction of all diseased leaves as soon as a single pustule is first evident on them, will hold the disease in check, especially if preceded by a thorough clean-up of the planting in the autumn and the destruction of all wild mallow plants in the vicinity of the hollyhocks.

LETTUCE

Drop, or rot

Drop, or rot, a fungous disease which is often destructive to lettuce in greenhouses, is distinguished by the sudden wilting of the plants. The disease is completely controlled by steam sterilization of the soil to the depth of two inches or more. If it is not feasible to sterilize the soil, fresh soil should be used for every crop of lettuce. The surface soil should be kept loose and dry. When the plants shade the ground, much less water should be used. Rotation with other crops should be practiced.

Gray mold, or Botrytis rot

Gray mold, or Botrytis rot, is of little importance outdoors but occasionally is destructive to lettuce under glass. Rotted plants are covered with a dirty-gray, fuzzy mold. The disease attacks weak plants mainly, and can be avoided to a considerable extent by securing a strong, vigorous growth. Soil sterilization is probably of little or no value. Low night temperatures in greenhouses will help to hold the disease in check.

Rhizoctonia, or bottom rot

Rhizoctonia is by far the most destructive rot of lettuce in this State. The rot starts when the bottom leaves rest on the ground, and gradually works up into the head, destroying first the blades of the leaves and less rapidly the midribs, but never rotting off the main stem of the plant. When the plants are grown under glass, care in watering to keep the leaves and the soil surface as dry as possible will help to hold the

disease in check. Soil sterilization, preferably by steam, insures crops free from the disease. In the field, thorough drainage, frequent shallow cultivation to keep the surface of the soil loose and dry, rotation with non-susceptible crops, and avoiding the use of fertilizer that is high in nitrogen or potash, are of value. But the principal control measure consists in raking up the crop refuse as soon as the harvesting is completed, and hauling the material away to a compost heap. Even though this entails much labor, it has proved very profitable.

Tipburn In lettuce affected by tipburn, the edges of the leaves die and turn brown. The disease is caused by weather conditions, as well as by an oversupply of fertilizer or by soil that is too alkaline.

Under glass, tipburn can be avoided. In the field, control measures are unknown but good cultural methods will help considerably. The disease is most troublesome during the hottest part of the summer, and seldom injures crops maturing in the fall.

MELON

(See *Cucumber, Melon, and Squash*, page 23)

NURSERY STOCK

Plant lice Plant lice on nursery stock may be controlled by dipping the tips of the plants in a solution of nicotine sulfate, 2 teaspoonfuls in a gallon of water, in which enough soap has been dissolved to make good suds.

San José scale Nursery stock that has been grown in nurseries infested with San José scale should be fumigated with hydrocyanic-acid gas after the trees have been dug, $\frac{3}{4}$ ounce of sodium cyanide being used for every 100 cubic feet of space. The fumigation should be continued for one-half to three-quarters of an hour. The trees should not be fumigated when wet, because the presence of moisture renders them liable to injury.

Fire blight Fire blight of nursery stock is the same disease as that described under *Apple* and *Pear*. It affects apples, pears, quinces, and hawthorns. Sources of infection, such as old infected apple and pear trees, should be cleaned out. Frequent regular inspections of stock should be made during the growing period, and all infected twigs should be removed and destroyed. All cut surfaces should be disinfected with mercuric-cyanide solution.

Leaf spot Leaf spot, known also as *yellow leaf* and as *shot hole*, is a disease causing a spotting, yellowing, and dropping of cherry leaves and a spotting of plum leaves. The diseased area often falls out, giving the leaves a perforated appearance described as *shot hole*. Control consists in making from five to seven applications of lime-sulfur (32° Baumé), diluted 1 gallon to 50 gallons of water, or dusting with sulfur and lead arsenate, 90-10.

OATS

Smut The commonest and most destructive disease of oats is smut, which (Figure 21) is carried over from one season to the next by the fungus spores on the seed. It may be prevented by treating the seed oats, before planting, with a solution of formaldehyde. The following steps should be taken in this treatment: (1) Dump the oat seed, after cleaning with a fanning mill, on a clean barn floor or a canvas, or into a tight wagon box. (2) Dilute 1 pint of 40-per-cent formaldehyde solution (formalin) with 1 pint of



FIGURE 21. OAT SMUT

water, and pour it into a quart hand-sprayer such as is commonly used about stables to keep flies away; this amount (1 quart) will treat 50 bushels of seed; if a smaller quantity of oats is to be treated, the amount of formaldehyde should be lessened accordingly. (3) While the oats are being shoveled from one pile to another, spray each shovelful with the solution; two strokes of the piston give about the right amount for a shovelful. (4) After the oats have all been treated in this way, pile them in a heap and cover them with blankets, canvas, or grain sacks which have been sprayed inside and outside with the solution, and leave the pile undisturbed for at least five hours, after which the oats may be bagged and drilled.

This treatment may be made at any time previous to sowing. Good control may be obtained also with either of two dusts, Ceresan or Smuttox. Some kind of mixing machine for mixing the dust thoroughly with the grain is necessary in order to insure that every kernel has a protective coating of dust. Directions for the treatment accompany the package of dust.

ONION

Onion maggots can be effectively controlled by spraying the plants with a lubricating-oil emulsion containing 2 per cent of oil. Commercial oil emulsions which contain $66\frac{2}{3}$ per cent of oil are diluted at the rate of 3 gallons to 100 gallons of either bordeaux 8-8-100 or clear water. Applications should

be started when the onions are 1 inch high, and repeated at weekly intervals. Good commercial control can be obtained with three applications. The spray is applied either by an attachment to a garden tractor, or by a long boom carried by two men and connected by a hose with a power spray rig driven along the edge of the field.

Onion tops frequently turn white and die as the result of the feeding punctures made by the minute yellowish onion thrips. The injury is known as *white blast*. No satisfactory method of control has been devised.

Mildew

Onion mildew, or *blight* as it is commonly called, is a fungous disease much like the blight of potatoes. A purplish mold on the tops, which later die, is the common symptom. Spraying is not deemed practicable. The following practices are recommended: (1) leaving as little diseased-onion refuse in the field as possible, and having well-drained soil; (2) rotations with other crops; and (3) the use of healthy seed and sets.

Smut

Smut can be detected by the black pustules on leaves and bulbs. It is harmful only where onions are grown extensively. It may attack the seedlings, killing them outright, or may appear on mature bulbs in the fall. Onions from sets or those started in clean soil and transplanted are not affected. Crop rotation should be practiced. The application of formaldehyde by means of a watering device attached to the drill gives almost complete control. One pint of the fungicide is diluted with 16 gallons of water, and application is made at the rate of 200 gallons of the solution to an acre. On wet soils a less amount of a more concentrated solution may be used (1 pint in 10

gallons of water). The liquid is discharged in the open furrow, either behind the seed or directly with it, in such a manner as to prevent washing of the seed in the furrow. Tanks of 3 gallons capacity for this purpose can be attached readily to a seed drill. A stopcock and tank outlet of 5/16-inch bore, when opened wide, will make the desired application per acre. A more even distribution of the formaldehyde is obtained if the top of the tank is made air-tight and the air is brought in through an outside standpipe which has its lower opening at the bottom of the tank and its outer end extending upward to a position even with the top of the tank. The solution may be applied with a sprinkling can if the seed is planted by hand. The seed should be covered to a depth of not more than 1 inch.

PEACH

Curculio — See under *Plum* (page 38).

Peach borer
(Figure 22)

— See under *Plum* (page 38). The adult peach borer is a clearwing moth. The larva burrows just under the bark near or below the surface of the ground; its presence is indicated by a gummy mass at the base of the tree. Paradichlorobenzene can be successfully used for the control of peach borers. The application should be made about the first of September. The earth is smoothed down around the base of the tree, and the powdered paradichlorobenzene is sprinkled on the soil in a circular band 1 or 2 inches wide entirely around the tree, care being taken that the inner part of the band is about 2 inches from the tree trunk. The earth is then mounded up to a height of 6 or 8 inches. On trees five years old or more, the dosage is 1 ounce of the chemical to a tree. On trees from three to five years old this should be reduced to ½ ounce, to avoid injury. With younger trees the borers should be removed by hand, with a knife or a flexible wire, in September.

San José scale— See under *Apple* (page 9).

Black spot, or scab, of peach

Black spot, or scab often proves injurious in wet seasons, and particularly in damp or sheltered situations.
(Figure 23)

While this disease attacks twigs and leaves also, it is most conspicuous and injurious on the fruit, where it appears as dark spots or blotches. In severe infections, the fruit cracks. In the treatment of black spot, it is of prime importance to insure a free circulation of air about the fruit. This may be accomplished by avoiding low sites, by pruning, and by removal of windbreaks. Spraying should be done according to the schedule on page 35.



FIGURE 22. PEACH BORER



FIGURE 23. BLACK SPOT
ON PEACH

Brown rot (Figure 24)

Brown rot is a serious fungous

disease of stone fruits, and one of the most difficult to control. The trees should be pruned so as to let in sunlight and air, and the fruit should be well thinned. Spraying should be done according to the schedule on page 35.

Leaf curl

Leaf curl is a fungous dis-

ease in which the leaves become colored, swollen, and distorted in spring, and drop in June and July. Elberta is an especially susceptible variety. The disease is easily and completely controlled by spraying the trees once, either late in the fall or early in the spring before the buds swell, with lime-sulfur solution diluted 1 to 15 in water. Bordeaux mixture, 5-5-50, also may be used.



FIGURE 24. MUMMY AND CANKER ON PEACH TREE, THE RESULT OF BROWN ROT

Yellows

Yellows is a degeneration disease. Its cause is unknown. It is contagious, and in some localities is serious. It is known by the premature ripening of the fruit, by red streaks and spots in the fruit flesh, and by the peculiar clusters of sickly, yellowish shoots that appear on the limbs here and there. Eradication is the only means of control. Diseased trees should be dug out and burned as soon as discovered.

PEAR

Codling moth — See under *Apple* (page 8).

False tarnished plant bug

The false tarnished plant bugs are small, green, sucking insects which puncture the newly set pears, causing them to become knotty (figure 25) and gritty. The trees should be sprayed thoroughly with nicotine sulfate, 1 pint in 100 gallons of water, with 4 or 5 pounds of soap added, just as the last of the petals are falling. The calyx spray for psylla is effective against this pest also (see spray schedule, page 37).

Leaf blister- mite

The control is the same as on apple (page 9).

Pear psylla

Pear psyllas are minute, yellowish, flat-bodied, sucking insects, which are often found early in the season working in the axils of the leaves and on the fruit. They develop into minute, cicada-like, jumping lice. The young psyllas secrete a large quantity of honeydew, in which a peculiar black fungus grows, giving

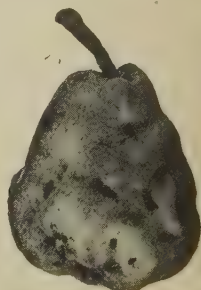


FIGURE 25. PEAR INJURED BY THE FALSE TARNISHED PLANT BUG

PEACH SPRAY SCHEDULE

Time of application	Spray mixtures	Enemy	Dust mixtures
Late fall or early spring, before buds swell	If scale is abundant, use Lime-sulfur, 11 gals. Water to make 100 gals.	San José scale Leaf curl	Dust not advised
	If scale is not important, use Lime-sulfur, 6½ gals. Water to make 100 gals.	Leaf curl	
When blossoms show pink	Dry-mix sulfur-lime, 25 lbs.* Water to make 100 gals. or Lime-sulfur, 2 gals. Water to make 100 gals.	Brown rot	Dusting sulfur
When shucks are falling	Dry-mix sulfur-lime, 25 lbs.* Lead arsenate, 2 lbs.† Additional hydrated lime, 8 lbs.† Water to make 100 gals.	Brown rot Scab Curculio	90-10 sulfur- lead-arsenate dust
Two or three weeks after shucks have fallen	Dry-mix sulfur-lime, 25 lbs.* Water to make 100 gals.	Brown rot Scab	Dusting sulfur
Two to four weeks before fruit ripens	Dry-mix sulfur-lime, 25 lbs.* Water to make 100 gals.	Brown rot Scab	Dusting sulfur

* Dry-mix sulfur-lime is prepared as described on page 51.

† The amount of lead arsenate is given for powder form; if paste form is used, twice as much is required. The additional lime is added to reduce the danger of arsenical injury.

the bark a characteristic sooty appearance. There may be four broods annually and the trees are often seriously injured. The commonest method of control consists of an application of lime-sulfur to kill the eggs of the overwintered flies, followed by a nicotine spray for the young psyllas a week after the petals have fallen and again in midsummer if necessary. Another method used with considerable success consists of an application of 3-per-cent lubricating-oil emulsion (page 52) in early spring to kill the overwintered flies and prevent egg laying, followed by nicotine sprays if the psyllas become abundant during the summer. Directions for these sprays are given on page 37.

Pear slug (Figure 26)

The small, slimy, dark green pear slugs skeletonize the leaves in June. A second brood appears in August. They can be controlled by thorough spraying with lead arsenate, 2½ pounds in 100 gallons of water or spray mixture.

Pear thrips

The pear thrips is a slender, brownish insect about 1/20 of an inch long. The thrips emerge from the ground in the spring and attack the opening buds, blasting the blossoms and preventing the fruit from setting. When the thrips swarm on the unopened buds, they can be killed by a thorough spray of nicotine sulfate, 1 pint in 100 gallons of either a miscible oil or a 3-per-cent lubricating-oil emulsion (see page 52 for dilutions). The tiny, white, young thrips appear during the blossoming period. The psylla-nymph spray applied after petal fall will kill many of these and reduce the numbers for the following year.

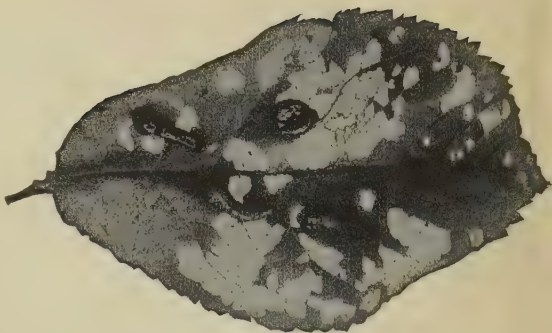


FIGURE 26. PEAR SLUGS SKELETONIZING A LEAF

San José scale — See under *Apple* (page 9).

Fire blight

The fire blight of pears is the same disease as the fire blight of apples, but the disease is more destructive to pears. It kills the twigs and the branches, on which the leaves suddenly blacken and die but do not fall. It also produces cankers on the trunk and the large limbs, and on the roots. Bartlett, Bosc, Clapp's Favorite, and Winter Nelis are very susceptible, while Anjou, Kieffer, Seckel, and a few other varieties have shown resistance. Blighted branches should be pruned out as soon as discovered, the cutting being made from 6 to 8 inches below the lowest evidences of the disease and the wound being disinfected with mercuric-cyanide solution, 1 to 500. Limb and body cankers should be cleaned out during the dormant season, as described for the fire blight on apple trees (page 11). All large wounds should be disinfected and covered with a coat of paint or gas tar. The orchard should be patrolled at least twice a week during the susceptible periods, and all infected twigs should be removed and burned at once.

**Scab
(Figure 27)**

Scab is a fungous disease very similar to apple scab, but not the same. It is very destructive to some varieties of pears, as, for example, Flemish and Seckel. The trees should be sprayed according to the schedule on page 37.



FIGURE 27. PEAR SCAB

PEAR SPRAY SCHEDULE

(Either lime-sulfur or oil sprays may be used to combat psylla early in the season. Schedules for both systems of control are given below)

Time of application	Spray or dust materials	Enemy
When lime-sulfur is used for psylla		
Cluster bud When cluster buds have separated (Bartlett); when they begin to separate (Kieffer)	Lime-sulfur, 11 gals. Water to make 100 gals.	Scale Scab Psylla eggs
Calyx One week after the petals have fallen	Copper sulfate, 2 lbs. Lime, 30 to 40 lbs. Lead arsenate, 2½ lbs.* Nicotine sulfate, 1 pt. Water to make 100 gals. (see note)	Codling moth Psylla nymphs Scab
About two weeks after petals have fallen	Lime-nicotine dust (2 per cent nicotine)	Psylla flies
	For scab-susceptible varieties, bordeaux mixture 2-40-100	Scab
Emergency application in summer when psylla becomes abundant	Copper sulfate, 2 lbs. Lime, 30 to 40 lbs. Nicotine sulfate, 1 pt. Water to make 100 gals.	Psylla nymphs Scab
	Lime-nicotine dust (2 per cent nicotine)	Psylla flies

When oil spray is used for psylla

(It is advised that oil sprays be used not more than two years in succession on the same trees, if the trees are old or weak)

Dormant Early in the spring when psylla flies first appear on the buds	Lubricating-oil emulsion diluted to contain 3 per cent of oil; or miscible oil, on maker's recommendation	Psylla Scale
Cluster bud When blossom buds separate in the cluster. This application is for varieties susceptible to scab, and in regions where scab is important on all varieties	Copper sulfate, 2 lbs. Lime, 30 to 40 lbs. Lead arsenate, 2½ lbs.* Water to make 100 gals. (see note)	Scab
Calyx One week after petals have fallen	Bordeaux mixture (2-40-100) Lead arsenate, 2½ lbs.*	Codling moth Scab
	If psylla nymphs are present, add 1 pt. nicotine sulfate to each 100 gals. of spray mixture	Psylla nymphs

For later sprays follow the preceding schedule.

Special Spray for Pear Thrips

Miscible oil 5 gals., nicotine sulfate 1 pt., water to make 100 gals. Effective only when the thrips swarm on the buds before the bud scales separate.

* The amount of lead arsenate is given for powder form; if paste form is used, twice as much is required.

Note: The use of lime-sulfur solution after the blossom is not advised because of the danger of foliage injury. For those who do not wish to use the lime-copper-sulfate mixture, the dry-mix sulfur-lime spray as described on page 51 is suggested.

PLUM

**Plum
curculio
(Figure 28)**

The adult plum curculio is a small snout-beetle, which inserts its eggs under the skin of the fruit and then makes a characteristic crescent-shaped cut beneath them. The grub feeds within the fruit and causes it to drop. When full-grown the grub enters the ground, changing in late summer to the beetle, which finally goes into hibernation in sheltered places. (For control measures, see *Plum Spray Schedule*, page 39.)

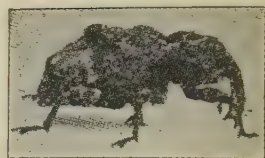


FIGURE 28. BEETLE OF
PLUM CURCULIO
(Enlarged)

Black knot

Black knot of plum is caused by a fungus which affects only the woody parts of the trees. Infection spreads most rapidly in the spring, from the knots on the limbs. All knots should be pruned out in the fall or early winter; the pruning should be finished before January. Knots on all plums, prunes, and cherries in the vicinity likewise should be pruned out. Applying the regular sprays given in the schedule (page 39) also aids in black-knot control.

**Brown rot
(Figure 29)**

Brown rot of plums is the same disease as brown rot of peaches. The mummied fruit should be destroyed or plowed under, and spraying should be done according to the accompanying schedule.



FIGURE 29. BROWN ROT ON
PLUM

Leaf spot

Leaf spot of plums is very similar to leaf spot of cherries, and may be controlled by spraying according to the accompanying schedule.

**Colorado
potato beetle**

The yellow-striped Colorado potato beetle emerges from hibernation in the spring, and lays masses of orange-colored eggs on the under side of potato leaves. The larvae are known as *slugs* and *soft-shells*, and cause most of the injury to the vines. They are best controlled by spraying with 3 pounds of calcium arsenate in 100 gallons of bordeaux mixture, the spray being applied as soon as the eggs begin to hatch.

Flea beetle

The small black flea beetles riddle the leaves with small holes and sometimes cause them to die. Bordeaux mixture as applied for potato blight protects the plants by making them distasteful to these beetles. (See under *Late blight*.)

**Pink and
green
potato aphid**

In recent years, in some seasons the pink and green potato aphid has become a serious pest to potatoes in southeastern New York. It feeds on a large number of wild and cultivated plants. When this pest becomes serious, the most promising method of control is dusting with a 3- or 4-per-cent-nicotine-lime dust on a still, warm day, using a crop duster with a canvas trailer. If a pressure of 400 pounds can be maintained, spraying with nicotine sulfate, 1 pint in 100 gallons of water, with 3 to 4 pounds of soap added, also is effective.

POTATO

PLUM AND PRUNE SPRAY SCHEDULE
(All varieties except Japanese)

Time of application	Spray mixtures	Enemy	Dust mixtures
While buds are dormant	Lime-sulfur, 11 gals. Water to make 100 gals.	San José scale	Dust not advised
	Lubricating-oil emulsion diluted to contain 3 per cent of oil	San José scale Fruit-tree lecanium Red mite	
When shucks are off young fruits	Lime-sulfur, 2 gals. Lead arsenate, 2½ lbs.* Water to make 100 gals.	Leaf spot Brown rot Curculio	85-15 sulfur-lead-arsenate dust
From 14 to 20 days later. Apply before rainy periods	Lime-sulfur, 2 gals. Water to make 100 gals.	Leaf spot Brown rot	Dusting sulfur
Before fruit ripens. Apply before rainy periods	Lime-sulfur, 2 gals. Water to make 100 gals.	Leaf spot Brown rot	Dusting sulfur

Japanese Varieties

On Japanese varieties, follow the same schedule as to time of application. For the dormant period, use the same application as for other varieties. For subsequent spray applications, instead of lime-sulfur solutions, use dry-mix sulfur-lime† or self-boiled lime-sulfur. For dust applications, use the same materials as for other varieties.

* The amount of lead arsenate is given for powder form; if paste form is used, twice as much is required.

† Dry-mix sulfur-lime is prepared as described on page 51.

**Potato
leaf hopper**

The potato leaf hopper, which attacks the apple also, is proving a serious pest to potatoes in many localities. It causes a browning and dying of the tips and margins of the leaves, known as *hopper burn*. It is best controlled by thorough spraying with bordeaux mixture, 5-5-50, as used for the control of blight. The plants should be kept covered with the mixture.

Black leg

Black leg is a bacterial disease affecting the potato vine and sometimes causing a dark-colored decay of the tuber. The stems become black and shrunken at the base, causing the vine to have an unhealthy, yellowish appearance and to die earlier than will healthy vines. Diseased plants should be eliminated from the field; no diseased, bruised, cracked, nor decayed tubers should be used for planting; and the seed should be treated with corrosive sublimate as directed under *Rhizoctonia*.

Scab is caused by a bacterium which attacks the surface of the tubers. It is carried over on diseased tubers and in the soil.

Common scab Tubers should be treated, before cutting, by soaking in corrosive sublimate, and they should be planted in clean soil. In general, on land that has become badly infested with scab it is best to plant other crops for several years. Lime or wood ashes should not be applied to potato soil. Green cover-crops should be turned under as often as possible in the crop rotation. Inoculated sulfur applied before planting has proved beneficial, but this is not always desirable up-State. The use of sulfate of ammonia in place of nitrate of soda in the fertilizer will tend to promote acidity in the soil and will thus reduce the amount of scab.

Early blight Early blight is a fungous disease, showing as a leaf spot, which may be so severe as to cause the vines to die. Affected vines produce small tubers and consequently low yield. A shallow rotting of the tuber also is caused occasionally. The vines should be sprayed with bordeaux mixture, 5-5-50, as for late blight.

(Figure 30)



FIGURE 30. EARLY BLIGHT OF POTATO

Fusarium dry rot**(Figure 31)**

Fusarium dry rot is a storage dry rot, in which the decay extends to the center of the tuber, the affected area at the surface having a wrinkled, sunken appearance, often with numerous white tufts of mold breaking through. Selecting clean tubers for planting, seed treatment, and care in handling the crop, will reduce the amount of this rot. Keeping the harvested tubers warm for a week or two previous to placing them in winter storage, will aid in the healing of wounds and thus prevent invasion by the rot-producing organism.

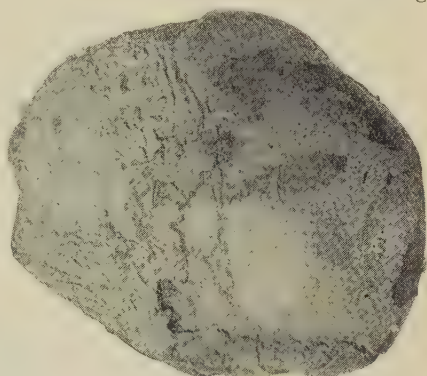


FIGURE 31. FUSARIUM DRY ROT OF POTATO TUBER

Late blight**(Figures 32, 33)**

Late blight is a fungous disease showing as a leaf blight and as a dry rot of tubers. Sometimes the tuber rot does

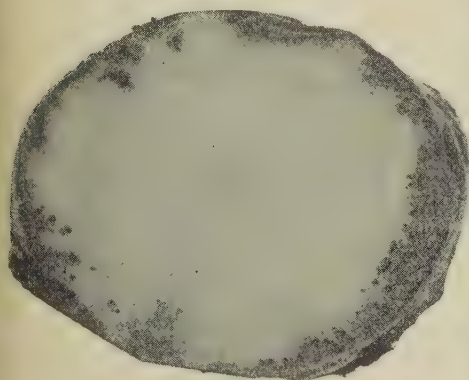


FIGURE 32. CROSS SECTION OF A POTATO TUBER AFFECTED BY BLIGHT ROT



FIGURE 33. POTATO LEAVES AFFECTED BY LATE BLIGHT

not show until after storage. The late blight is often confused with tipburn, arsenical injury, or flea-beetle injury. The plants should be sprayed five to ten times with bordeaux mixture, 5-5-50, beginning when they are 6 inches high and continuing throughout the growing season. There should be three nozzles for each row, and the pressure should be as high as 200 to 300 pounds per square inch. Late spraying on late varieties is especially necessary.

Rhizoctonia is a fungous disease showing as numerous black bodies of various sizes, known as *scurf*, on the surface of tubers, (Figures 34, 35) and as reddish brown cankers on young sprouts, often causing their death. The disease brings about also a rosetting of the vines and the production of many small tubers near the surface of the soil.

Crops should be rotated, and seed tubers should be treated with corrosive sublimate in the following manner: The tubers should be soaked for 1½ hours in a solution made by adding 4 ounces of powdered corrosive sublimate to every 30 gallons of water. As the powder is not readily soluble in cold water, it should first be dissolved in a quart or more of hot water. A non-metal vessel should be used for this purpose. Wooden troughs or tubs may be used for the treatment, but it is believed that barrels make the handiest containers. A 1-inch hole, fitted with a wooden plug, is made in the

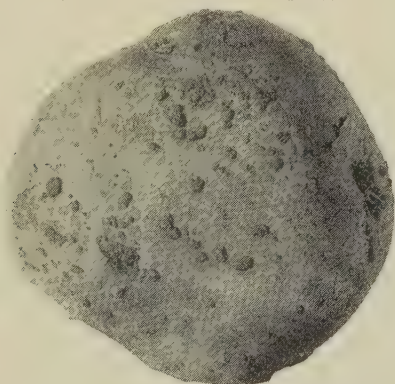


FIGURE 34. SCLEROTIA OF RHIZOCTONIA ON POTATO TUBER

side and near the bottom of each barrel. The barrels are set upon a platform which is high enough so that the solution may be drawn off in a tub or a pail. They are then filled with uncut potatoes, and the potatoes are covered with the solution. At the end of 1½ hours, the liquid is drawn off, the tubers are emptied out, and the barrels are refilled. More of the fresh solution is added to replace that taken up by the treated seed. Treated tubers should be spread out in shallow piles and allowed to dry. The plants will come through the ground sooner if the seed is permitted to green and start sprouting before planting. The treatment may be given, however, at any time previous to cutting.

Corrosive-sublimate solution loses strength with each successive treatment. It should not be used more than three times unless some of the original solution is added, and even then it should be thrown away after the fourth using. Labor and mate-

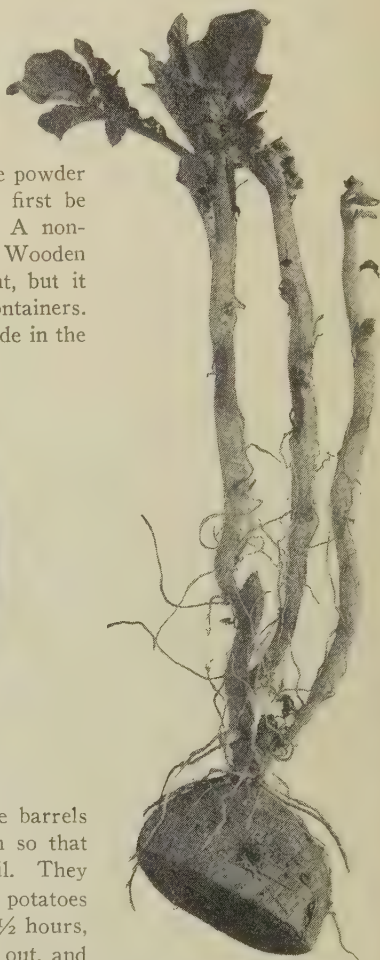


FIGURE 35. RHIZOCTONIA ON YOUNG SHOOTS OF POTATO

rials may be saved by testing the strength of the solution by means of potassium iodide. The necessary directions may be obtained from a county agent or an extension specialist.

Calomel (2½ pounds in 30 gallons of water) or an organic-mercury compound may be used as a dip in place of the corrosive-sublimate treatment.

Tipburn Tipburn is a dying and blackening of the tips and the margins of leaves, caused by hot, dry weather following favorable conditions for growth. Good cultural practices, combined with thorough spraying as for late blight, will materially reduce the amount of injury. A similar injury is often produced by the potato leaf-hopper. Careful spraying with bordeaux mixture will do much to hold this pest in check.

Wilt Wilt is a disease produced by one of several fungi which cause a wilting and dying of the lower leaves and a discoloration of the sap vessels of vines and tubers. This discoloration shows in the tuber as a dark ring on the surface of a slice across the stem end. A similar blackening may be caused by hot soils or by frost. Nevertheless, darkened tubers should be rejected as seed, and crop rotation should be practiced. Tubers from plants affected with wilt should not be used for seed.

Mosaic, leaf roll, and other degeneration diseases The diseases transmitted through the tuber, such as mosaic, leaf roll, and spindle tuber, cause a great reduction in yield. For each of these, the name is descriptive. The most practical way to eliminate these diseases is to procure seed as nearly free from disease as possible. In case the diseases are present to only a very limited extent, they may be controlled to a considerable degree by careful roguing of the seed plot. This seed plot should be located at some distance from the main field, and should comprise an area equal to about one-twelfth that of the main planting. The hills should be planted in tuber units or hill units. Two or three inspections of the seed plot during the growing season are necessary. All diseased, weak, or "off-type" plants should be removed as soon as detected. If the roguing has been thorough, only plants which are apparently healthy will remain at digging time. The crop should be dug by hand. At this time tubers from uniform high-yielding hills should be selected as seed for the next year's seed plot. The remainder of the crop should be used for planting the main field. Growers who have no time to do roguing and make selections should buy certified seed.

PRUNE

(See *Plum*, page 38)

QUINCE

Quince curculio The quince curculio is somewhat larger than the plum curculio, and differs from it in its life history. The grubs leave the fruits in the fall and enter the ground, where they hibernate and transform to adults the next May, June, or July, depending on the season. The trees should be sprayed with lead arsenate, 3 pounds in 100 gallons of the proper fungicide, when the beetles first appear, and the application should be repeated in about a week. All culls and drops should be picked up and destroyed before the grub leaves the fruit.

Round-headed borer—See under *Apple* (page 9).

San José scale — See under *Apple* (page 9).

Fire blight — See under *Apple* (page 10).

Fruit and leaf spot

(Figure 36)

Fruit and leaf spot of quince is a fungous disease which produces round, reddish brown spots on fruit and leaves. A pink application and a calyx application should be made, followed, in a wet season, by two or three other applications, timed so as to come before rain periods. Either lime-sulfur, 1-40, or bordeaux mixture, 3-8-50, may be used. Commercial control has been obtained also with 90-10 sulfur-lead-arsenate dust.

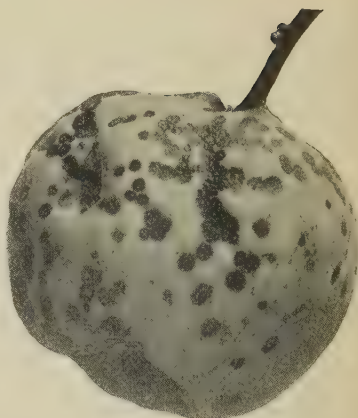


FIGURE 36. FRUIT SPOT ON QUINCE

RASPBERRY

Cane borer

The larva of the cane borer is a grub which burrows down through raspberry canes, causing them to die. In laying her eggs, the adult female beetle girdles the tip of the cane with a ring of punctures, making it wither and droop. In midsummer the drooping tips should be cut off and destroyed.

Sawfly

The greenish, spiny larvae of the sawfly feed on the tender leaves in the spring. The bushes should be sprayed with lead arsenate, 3 pounds in 100 gallons of water.

Anthraxnose

(Figure 37)

Anthraxnose is very destructive to black raspberries and to the purple variety Columbian, but is not often injurious to the red varieties. It is detected by the circular or elliptical, gray, scab-like spots on the canes. Young plants should not be taken from diseased plantations. All old canes and badly diseased new ones should be removed as soon as the fruit has been gathered. Weeds should be kept down. An application of lime-sulfur, 1 to 10, is advised when the new laterals are out about $\frac{1}{2}$ inch. Later applications are not recommended under New York conditions.

Blue stem, or wilt

Blue stem, or wilt, is a destructive disease affecting black varieties. Fruiting canes wilt suddenly, and die. Green canes and fruiting laterals turn a dark blue just before wilting. The wilt fungus lives over in the soil. Blue stem is likely to occur if black raspberries are planted following potatoes, eggplant, tomatoes, salsify, okra, or cotton that have been affected by the disease. The control of blue stem will probably consist in the use of resistant strains or varieties.

Crown gall, or root knot

Crown gall, or root knot, is often destructive, particularly to red varieties. It is detected by the large, irregular knots on the roots and at the crown underground. It is a contagious

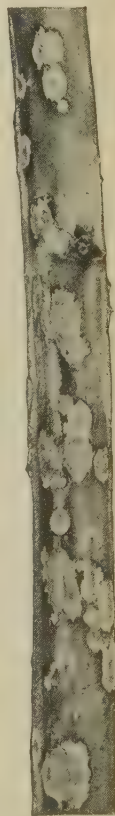


FIGURE 37. RASPBERRY ANTHRAXNOSE

disease. Plants showing root knots should never be set. No planting should be done on infested land. The same disease occurs on many kinds of plants, particularly rosaceous fruits.

Mosaic

Mosaic is the cause of the running-out of varieties of red and purple raspberries. The most noticeable effect of mosaic is the stunting of the canes. The leaves on the new canes arising each year from the roots of diseased plants are mottled. The leaves on diseased fruiting canes are small, mottled, and distorted. The fruit is inferior in quality, it crumbles, and the yields are low. Most of the desirable commercial varieties, such as Cuthbert and Columbian, do not remain free from mosaic unless the diseased plants are carefully removed during the first and the second year (called *roguing*). Mosaic-free stock certified by some responsible agency should be planted. Roguing should be done frequently in the first year, and at least three times in the second year.

Red rust

Red rust is often serious on black varieties but does not affect red varieties. It is the same as red rust of blackberry. Infected plants, both wild and cultivated, should be dug up and destroyed.

ROSE

The green aphids, or plant lice, usually work on the buds of roses, and the yellow leaf hoppers feed on the leaves. The bushes

Aphis and leaf hopper (Figure 38)

with $\frac{1}{4}$ pound of ordinary laundry soap added.

Rose chafer — See under *Grape* (page 27).

Rose slug — Treat the same as for pear slug (page 35).

Black leaf spot

Black leaf spot is one of the commonest diseases of the rose. It causes the leaves to fall prematurely. Spraying with bor-

deaux mixture, 5-5-50, beginning as soon as the first spots appear on the leaves, will control the disease, but the use of this fungicide may be objectionable in that it discolors the foliage. Dusting the plants with finely ground sulfur will control the disease and cause little discoloration. Ammoniacal copper carbonate may be used on roses grown under glass, but is less effective than either bordeaux mixture or sulfur-lead dust. A green sulfur dust is available. Applications should be made once a week until the disease is under control.

Mildew

Mildew is a surface-feeding fungus. It can be killed by the use of sulfur. For greenhouse roses, the steam pipes should be kept painted with a paste made of equal parts of lime and sulfur mixed with water. Outdoor roses that have become infested with mildew may be dusted



FIGURE 38. ROSE APHIDS, OR PLANT LICE

with sulfur or sprayed with lime sulfur, 1-50, or bordeaux mixture, 4-4-50. The plants should be sprayed or dusted two or three times, at intervals of a week or ten days.

SQUASH

(See *Cucumber, Melon, and Squash*, page 23)

STRAWBERRY

White grub (Figure 39)

The large, curved, white grubs that attack the roots of strawberry plants are the larvae of the common June beetles. They live in the ground, feeding on the roots of grasses and weeds.

Strawberries should not be planted on freshly plowed sod land, but should be preceded by some other crop, preferably clover or buckwheat or some cultivated crop not subject to injury by grubs.

Leaf spot

Leaf spot is the commonest and most serious fungous disease of the strawberry. It is called also

rust and *leaf blight*. The leaves show spots which are at first of a deep purple color but later enlarge and the center becomes gray or nearly white. The fungus passes the winter in the old, diseased leaves that fall to the ground. The control measure of first importance is the renewal of the strawberry beds every two or three years. If leaf spot is prevalent, the vines should be mowed off after the crop has been picked, and the leaves burned. Both spraying and dusting of strawberries for leaf-spot control are still in the experimental stage. Spraying with bordeaux mixture has proved profitable in many localities. A 4-4-50 or 3-3-50 bordeaux mixture, or a 15-85 copper-lime dust, is recommended. The first application should be made when the leaves are unfolding in the spring, and the new growth should be covered before rains until the berries are from a third to half grown. An application after blossoming is effective in preventing injury by the fungus on the fruitstalks.

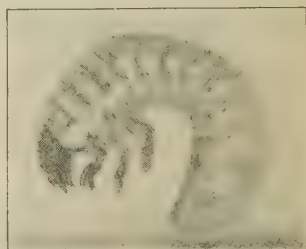


FIGURE 39. WHITE GRUB

TOMATO

Bacterial canker

Bacterial canker of tomato has been destructive during the past few years. It causes a wilting, rolling, and browning of the leaves, usually first on one side of the plant only. The stems may have streaks or may crack open. Later the whole plant may die.

Control measures consist in (1) obtaining seed from healthy plants, (2) plowing under deeply all diseased-tomato refuse, (3) rotating with other crops for three or four years, and (4) treating the seed with corrosive sublimate (1 tablet in 3 pints of water) for five minutes, then rinsing and drying.

Blossom-end rot

Blossom-end rot is a sunken dry rot, becoming black, at the blossom end of the fruit. It is not a parasitic disease. It may be brought on by a sudden check in the water supply, and also by continued successive waterings. It may be somewhat reduced

by avoiding heavy applications of stable manure, and by practicing good cultural methods in order to conserve moisture and afford a more uniform supply to the plants throughout the season.

Leaf mold Leaf mold is primarily a greenhouse disease, in which yellow and dead areas, covered on the lower surface by an olivaceous mold, appear on the leaf, causing it to die. The disease can be prevented to a considerable extent by exercising caution in watering, and by ventilating to keep the tomato foliage and the greenhouse atmosphere as dry as possible. Heating sulfur (not burning it) on small electric hot-point stoves once a week also has proved successful during warm weather. In winter the fungus can be held in check by lowering the night temperature of the greenhouse.

Leaf spot Leaf spot is the most destructive foliage disease of the tomato in New York. It is a fungous disease, and its distinguishing character is that it begins on the lower leaves and works toward the top, killing the foliage as it goes. It is controlled with difficulty because it is carried over winter in the diseased leaves and tops that fall to the ground. When setting out plants, all the lower leaves that touch the ground should be pinched off; also any leaves that show suspicious-looking dead spots. Young plants should not be set in a field that has grown tomatoes until after an interval of at least two years. The disease often starts in the seedbed. For this reason the plants should be sprayed or dusted three to five times, at weekly intervals, before they are transplanted. After the plants are in the field, spraying with bordeaux mixture, 5-5-50, is advised in special cases only, for spraying tends to delay the ripening of the fruit.

Mosaic and streak The symptoms of mosaic on tomatoes are similar to those of the same disease on potatoes, being characterized by lighter green blotches in the darker green color of the leaves, the darker area often being cupped up, giving the foliage a warty appearance. Also, the fruit may have water-soaked, greasy-looking spots. Streak is a form of mosaic. It causes brown stripes on the stem, and in severe cases it may cause the death of the entire plant. The virus that causes these diseases may live in the soil for three or four months, and remains alive year after year in the perennial weeds related to the potato and the tomato. The streak seems to be increased by the use of heavy applications of barnyard manure or of commercial fertilizer high in nitrogen. Control measures are as follows: (1) in the greenhouse, avoiding the growing of tomatoes in soil where the crop has been grown within at least six months; (2) destroying all old living tomato plants before new ones are started in the same greenhouse; (3) avoiding the growing of flowers that belong to the family Solanaceae in the same greenhouse; (4) using fertilizers fairly low in nitrogen and fairly high in superphosphate; (5) preventing workers from spitting tobacco juice in the plant beds, for the tobacco mosaic is the same as that on the tomato and is carried in the tobacco juice; (6) avoiding the use of a knife in pruning greenhouse tomatoes, or, if a knife is used, dipping it repeatedly in formaldehyde, 1 to 20; (7) destroying all weeds within a radius of at least 150 feet around the greenhouse, either by cultivating the soil or by making a lawn and mowing it regularly with a lawn mower.

Wilt Several soil fungi cause wilt of tomatoes. In the greenhouse, these fungi can be exterminated readily by means of soil sterilization. In the field, there should be long rotation of crops, together with the burning of diseased tomato vines. There are now available many resistant varieties, as the Norton, the Marvel, the Marglobe, and others.

TURNIP

(See *Cabbage, Cauliflower, and Brussels Sprouts*, page 17)

WHEAT

Loose smut Loose smut of wheat is conspicuous in the field at heading time. Both grain and chaff are attacked and are transformed into a loose, black powder, most of which is blown away by harvest time, leaving the stalk bare. The disease is common and destructive. This smut is not controlled by treatment with formaldehyde or other chemicals, but it can be prevented by treating the seed with hot water, as explained on page 53, or by using seed from fields known to have been free from smut.

Rusts There are two common rusts of wheat: one produces numerous small, orange pustules on the leaves; the other produces large, brick-red pustules, both on the stem and on the leaves, and these are followed by a later stage in which the plant is injured by long, black, rust lesions. The latter rust is made more virulent by the presence of the common barberry (*Berberis vulgaris*), since the barberry serves as a host for the spring stage of the fungus. In localities where this rust is troublesome, all bushes of the common barberry should be dug up and burned. This does not apply to the smaller Japanese variety, which is harmless.

Stinking smut Stinking smut is not readily detected until harvest time. The affected heads appear nearly normal, the kernels only being attacked. The diseased kernels contain a brown, foul-smelling powder, and may be crushed easily between the thumb and the finger. The disease may be controlled by dusting the seed with a fine copper-carbonate dust (2 ounces to 1 bushel of seed), using a mixing machine, or by treating the seed with formaldehyde solution (1 pint to 45 gallons of water), immersing it in the solution long enough to skim off the smutted kernels, which rise to the surface, and then spreading it out to dry.

Other diseases There are a number of other serious wheat diseases, such as glume and leaf blotch, take-all, anthracnose, scab, and Helminthosporium spots, which cause much loss annually. No direct means of control are available. Long rotations should be practiced, and, when any of the diseases are severe enough to cause an appreciable decrease in yield, seed wheat should be obtained from a field which has been inspected during the growing season and found free from the diseases in question.

INSECTICIDES AND FUNGICIDES

Lead arsenate Lead arsenate is the commonest arsenical poison and is the kind almost exclusively used on fruit trees. It is much safer for the foliage, stays suspended in water longer, and protects the plant for a longer time, than the earlier arsenicals such as paris green and london purple. It is now used almost entirely in the convenient powdered form.

PROPORTIONS FOR MIXING LEAD ARSENATE

To make 1 gallon of spray, use 2 tablespoonfuls
 To make 5 gallons of spray, use 10 tablespoonfuls
 To make 25 gallons of spray, use $\frac{3}{4}$ pound
 To make 100 gallons of spray, use 3 pounds

(All directions in this bulletin refer to the powder form.)

Calcium arsenate

Calcium arsenate, because of its cheapness and higher arsenical content, is used on plants which are resistant to arsenical injury. It is safe for use as a spray or a dust on potatoes, cabbage, cucumbers, and melons.

Arsenical dusts

For dusting purposes, the arsenical (either lead arsenate or calcium arsenate) is mixed either

with sulfur to make a combination dust for both insects and fungous diseases, or with hydrated lime merely to dilute it. In either case the mixture should contain 10 to 15 per cent, by weight, of the arsenical, depending on the insects against which it is to be used and the resistance of the plant to arsenical injury.

Nicotine sulfate

For spraying purposes, nicotine is usually sold in the form of nicotine sulfate. The standard

brands of nicotine sulfate on the market contain 40 per cent of nicotine. Nicotine sulfate is not volatile, but the fumes of the nicotine are liberated when the material is applied as a spray in combination with lime-sulfur, dry-mix sulfur-lime, or bordeaux mixture. If used in water alone, nicotine sulfate is not effective unless 3 to 5 pounds of soap is dissolved in each 100 gallons.

PROPORTIONS FOR MIXING NICOTINE SULFATE, 40 PER CENT, TO MAKE A 1-800 DILUTION

To make 1 gallon of spray, use $1\frac{1}{2}$ teaspoonfuls

To make 5 gallons of spray, use 1 fluid ounce

To make 25 gallons of spray, use $\frac{1}{4}$ pint

To make 100 gallons of spray, use 1 pint

"Free" nicotine

Preparations are on the market containing 40 to 50 per cent of nicotine in the free, or uncom-

bined, form. These are effective without the necessity of adding soap to the spray solution. They are used mainly in spraying and fumigating for greenhouse pests.

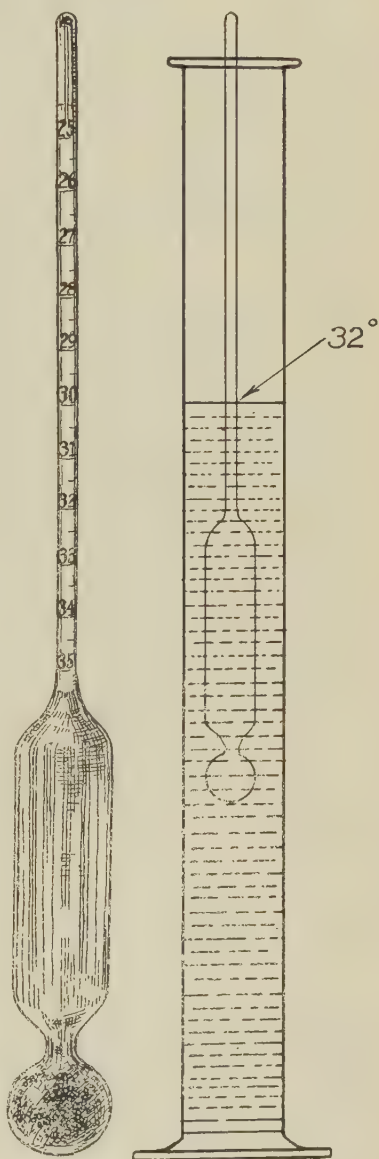


FIGURE 40. HYDROMETER USED FOR TESTING CONCENTRATED LIME-SULFUR SOLUTIONS (PAGE 50)

Nicotine dust

Nicotine dust is usually made by mixing nicotine sulfate with hydrated lime. Nicotine-lime dusts can be bought ready-mixed, or can be prepared in a ball mixer or a self-mixing duster. Since the commercial brands of nicotine sulfate contain 40 per cent, by weight, of nicotine, 5 pounds, or 2 quarts, of this material is added to 95 pounds of hydrated lime to give a dust containing 2 per cent of nicotine. For a 3-per-cent-nicotine-lime dust, $7\frac{1}{2}$ pounds, or 3 quarts, is required. Since the strength of the nicotine is likely to deteriorate if the dust is stored for a considerable time, a fresh product is desirable.

Lime-sulfur solution

Lime-sulfur has a wide range of usefulness in spraying. At the higher concentrations it is effective against peach leaf-curl, San José scale, oyster-shell scale, and the eggs of the pear psylla. At the summer strength of 1 to 40, it is the grower's chief reliance in the control of such important diseases as apple scab and cherry leaf-spot, and when used throughout the summer it prevents injury from the European red mite.

Lime-sulfur solution is made by boiling freshly burned high-grade calcium lime with sulfur and water. The commercial concentrate generally sold is a clear orange-red solution, usually containing between 25 and 26 per cent of total dissolved sulfur and testing 32° to 33° Baumé. While most commercial brands test approximately as indicated, there may be considerable variation and the safest plan is to test each barrel with a hydrometer (figure 40), preferably marked with a Baumé scale. All recommendations in this bulletin as to the quantity of lime-sulfur to be used are based on a solution testing 32° Baumé. If solutions of other strengths are used, corrections should be made according to the following table:

LIME-SULFUR DILUTION TABLE

Hydrometer reading in degrees Baumé	Gallons of lime-sulfur used in 100 gallons of spray			
32° (Standard test)	11	$6\frac{1}{2}$	$2\frac{1}{2}$	2
20°	$22\frac{1}{4}$	13	5	4
21°	$20\frac{3}{4}$	$12\frac{1}{4}$	$4\frac{3}{4}$	$3\frac{3}{4}$
22°	$19\frac{1}{2}$	$11\frac{1}{4}$	$4\frac{1}{4}$	$3\frac{1}{2}$
23°	$18\frac{1}{4}$	$10\frac{1}{2}$	4	$3\frac{1}{4}$
24°	17	10	$3\frac{3}{4}$	3
25°	16	$9\frac{1}{4}$	$3\frac{1}{2}$	3
26°	15	$8\frac{3}{4}$	$3\frac{1}{4}$	$2\frac{3}{4}$
27°	$14\frac{1}{4}$	$8\frac{1}{4}$	$3\frac{1}{4}$	$2\frac{1}{2}$
28°	$13\frac{1}{2}$	8	3	$2\frac{1}{2}$
29°	$12\frac{3}{4}$	$7\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{1}{4}$
30°	$12\frac{1}{4}$	$7\frac{1}{4}$	$2\frac{3}{4}$	$2\frac{1}{4}$
31°	$11\frac{1}{2}$	$6\frac{3}{4}$	$2\frac{1}{2}$	2
32°	11	$6\frac{1}{2}$	$2\frac{1}{2}$	2
33°	$10\frac{1}{2}$	$6\frac{1}{4}$	$2\frac{1}{4}$	2
34°	$10\frac{1}{4}$	6	$2\frac{1}{4}$	$1\frac{3}{4}$
35°	$9\frac{3}{4}$	$5\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$

Dry lime-sulfur

Dry lime-sulfur is a yellow, pungent powder obtained by evaporating the concentrated liquid lime-sulfur solution. It is less bulky and easier to handle than the liquid concentrate, but is more expensive. With the dry lime-sulfur, 4 pounds is required to equal 1 gallon of the liquid concentrate; for example, if the spray formula calls for

2½ gallons of lime-sulfur to make 100 gallons of spray, 10 pounds of dry lime-sulfur would be necessary to give an equivalent dilution.

Dry-mix sulfur-lime

Dry-mix sulfur-lime is known also as *New Jersey dry-mix* and as *wettable sulfur*. It can be bought ready-mixed or prepared according to the following formula: superfine sulfur, 16 pounds; hydrated lime, 8 pounds; casein spreader, 1 pound. It takes 25 pounds of this mixture to make 100 gallons of spray. The materials are mixed dry in the proportions given, a screen or a dust mixer being used, and the mixture is stored in a dry place until needed. With the tank half full of water and the agitator running, the required quantity of the dry material is washed through the strainer into the tank with the aid of the open gun. Dry-mix sulfur-lime is used on peaches and Japanese plums, and for the summer applications on varieties of apples that are subject to spray injury from lime-sulfur.

Wettable sulfur

The name *wettable sulfur* is applied to mixtures of sulfur and various substances, in which the sulfur particles are held in suspension when mixed with water to make a spray. It is a substitute for lime-sulfur, very much like dry-mix sulfur-lime.

Sulfur

Sulfur, especially extra finely ground sulfur flour, possesses considerable value as a fungicide. The sulfur, of suitable fineness, may be dusted over the plants to protect them from fungi. In

rose houses it is mixed with half its bulk of lime and made into a paste with water. This is painted on the steam pipes. The fumes condense on the plants and destroy mildew. Mixed with powdered lead arsenate at the rate of 90 pounds of sulfur to 10 pounds of lead arsenate, it has proved effective in the control of biting insects and of many fruit diseases. Ordinary sulfur—that is, flowers of sulfur and sulfur flour as purchased at drug stores—is too coarse for use as a dust. Dusting sulfur, to be effective, should be of 300-mesh grade or of colloidal fineness. A “fluffer” should be mixed with it to prevent packing and make it “flow” well in the duster. A sulfur dust that has been dyed green offers considerable advantage to the grower of ornamental plants, on which discoloration of the foliage is objectionable.

Bordeaux mixture

Bordeaux mixture is made by mixing a dilute solution of copper sulfate (blue vitriol) with a dilute milk of lime. The mixture may be made of different strengths by using different quantities of the copper sulfate and lime to a given quantity of water. A

mixture made of 3 pounds of copper sulfate and 3 pounds of lime to 50 gallons of water is indicated by the formula 3-3-50; one made of 4 pounds of copper sulfate and 4 pounds of lime to 50 gallons of water, by 4-4-50; one made of 5 pounds of copper sulfate and 5 pounds of lime to 50 gallons of water, by 5-5-50; and so on. In order to make bordeaux mixture of any strength, the procedure should be as follows:

Stock solution of copper sulfate.—A stock solution of copper sulfate may be made in a barrel, by dissolving 40 pounds of copper sulfate in 40 gallons of water. A gallon of the solution thus contains 1 pound of copper sulfate. In case large quantities of stock solution are needed, 2 pounds of copper sulfate may be dissolved in 1 gallon of water. If the crystals are placed in a gunny sack and suspended so as to be just beneath the surface of the water, they will dissolve in the course of three or four hours.

Stock lime.—A stock mixture of lime may be made by placing 40 pounds of fresh calcium (burnt, or lump) lime in a barrel, and slaking by the gradual addition of water. Care must be taken not to drown the lime. When all has become pulverized by the slaking, water is added to make a paste, which should be allowed to

stand in this condition for an hour or more. Then enough more water is added to make 40 gallons. This should not be allowed to dry out.

A high-grade calcium hydrated lime (known as *chemical hydrated lime*) may be used in place of burnt lime, but air-slaked lime should never be used. The mixture is made by placing 56 pounds of the hydrated lime in a barrel and adding to it 40 gallons of water, stirring in the meantime. Bordeaux mixture made by adding hydrated lime directly to the tank, is coarser and less effective as a fungicide than that made with lime which has stood in the water for a day before being used.

Making the mixture.—The sprayer is filled three-fourths full of water. If a 5-5-50 solution is desired, 5 gallons of copper-sulfate stock solution is added to this water for every 50 gallons of mixture to be made. The solution requires stirring until it is well diluted, after which 5 gallons of the stock mixture of milk of lime is added to each 50 gallons of mixture. The limewater should be run through a strainer in order to prevent the large particles of lime from getting into the sprayer tank. While the milk of lime is being added to the dilute copper-sulfate solution in the sprayer tank, the material in the tank should be stirred constantly. The sky-blue bordeaux mixture will result. Enough water to make the required amount of mixture is then added.

Testing the mixture.—The mixture should be tested with a few drops of a solution of potassium ferrocyanide, if there is uncertainty regarding the strength of lime used. This is made by dissolving crystals of potassium ferrocyanide in soft water. Five cents' worth of crystals dissolved in a pint of water will provide enough of the solution to last throughout the season. Should a brown precipitate result when a few drops of this solution are added to the bordeaux mixture, it would indicate that more lime milk is needed to neutralize the copper-sulfate solution. When sufficient lime is added, no brown precipitate will be formed by the potassium-ferrocyanide solution. Bordeaux mixture not properly neutralized will burn the foliage of plants to which it is applied. It is unnecessary to measure the milk of lime in making the bordeaux mixture if the mixture is tested from time to time with ferrocyanide solution while the lime is being added. The test will indicate when sufficient lime is present.

Ammoniacal copper carbonate

Ammoniacal copper carbonate is composed of 5 ounces of copper carbonate, 3 pints of ammonia, and 50 gallons of water. The ammonia is diluted in seven or eight parts of water, and a paste is made of the copper carbonate with a little water. This paste is added to the diluted ammonia and stirred until it is dissolved. Enough water to make 50 gallons is added. This mixture loses strength on standing, and should be made as required. It is used in place of bordeaux mixture when one wishes to prevent the coloring of maturing fruits or ornamental plants. It is not so effective as bordeaux mixture.

Oil sprays

Lubricating oils recommended for spraying purposes can be purchased on the market in the form of stable, concentrated emulsions. The oil content of these preparations should be stated on the label, and is usually about 66 per cent. When a stock emulsion of this concentration is used, it should be diluted according to the following table:

For 100 gallons

For a 2-per-cent emulsion, use 3 gallons of stock emulsion
 For a 3-per-cent emulsion, use 4½ gallons of stock emulsion
 For a 4-per-cent emulsion, use 6 gallons of stock emulsion
 For a 6-per-cent emulsion, use 9 gallons of stock emulsion
 For an 8-per-cent emulsion, use 12 gallons of stock emulsion

While these stock emulsions are reasonably stable, if they are allowed to freeze or are stored for considerable periods of time some of the oil may separate out. If the stock emulsion shows any considerable amount of free oil and preliminary efforts indicate that it will not emulsify properly, it is unsafe for use and should be discarded.

Miscible oils

Miscible oils are proprietary oil products which usually contain a higher oil content than do the lubricating-oil stock emulsions, and are much more expensive. Since miscible oils vary in composition according to the formulas of the different manufacturers, it is

advisable to follow the manufacturers' recommendations as to dilution and methods of application.

Soaps

Soaps are used with nicotine sulfate and water to liberate the nicotine and increase the wetting and spreading qualities of the spray. They are used also in preparing certain boiled oil

stock emulsions.

The commonest soap for spraying purposes is potash fish-oil soap, a soft soap which dissolves easily in water. Soda fish-oil soap is a harder soap which is sometimes used but is more difficult to dissolve. Laundry soaps also are occasionally used, particularly in the granulated or flake form; but they are not easily dissolved, and vary greatly in the amount of free alkali present.

Soaps vary considerably in water content. The quantity to be used therefore varies from 3 to 5 pounds in 100 gallons of spray. For safety, a soap with only a little free alkali should be used. In no case should soap be used in combination with lime-sulfur.

Corrosive-sublimate solution

A mixture of 1 ounce of corrosive sublimate with $7\frac{1}{2}$ gallons of water makes an effective solution for treating seed potatoes, which should be soaked for one and one-half hours. For treating seed-beds, especially those of cabbage and cauliflower, 1 ounce of corrosive sublimate dissolved in 10 to 15 gallons of water is used.

One antiseptic tablet dissolved in a pint of water and stored in glass makes a solution suitable for disinfection of wounds or for treating such garden seeds as cabbage, cauliflower, turnips, and brussels sprouts. When more dilute it can be used also on tomato seed. Only wooden or glass vessels should be used to contain the solution, as it reacts with metal and thereby loses strength. It is very poisonous, and is injurious to tools.

Formaldehyde solution

Commercial formaldehyde solution contains about 40 per cent of the gas formaldehyde. At various strengths it may be used for the control of oat smut and of stinking smut of wheat. It is used in dilutions of 1-50 to 1-100 for sterilizing greenhouse or plant-

bed soil. Stronger solutions are used as a drip, in sowing onion seed, to prevent smut. The Iowa Agricultural Experiment Station suggests its use, diluted at the rate of 1 pint in 15 gallons of water and heated to 120° F., for treating potato seed. The tubers are left in this hot solution for three minutes, and are then removed and placed in a covered pile for four or five hours. As a seed disinfectant, however, formaldehyde has in great part been replaced by corrosive sublimate.

Hot water

The smuts of certain cereals may be controlled by the use of hot water in treating the seed. The following modified Jensen method is recommended for treatment of seed for the loose smuts of wheat and barley. This applies only to the treatment of small quantities of seed for a seed plot from which clean seed for the general crop may be obtained.

First, all seed should be run through the fanning mill in order to remove the light, diseased seed. The seed is then soaked in cold water for not less than four nor

more than six hours. It is next removed, drained, and soaked in hot water—wheat seed for ten minutes at 129° F., and barley seed for thirteen minutes at 126° F.

SCALE OF TEMPERATURE TO BE USED*

Barley

Time	15 minutes	13 minutes	10 minutes
Temperature (Fahrenheit)	125°	126°	127°

Wheat

Time	15 minutes	10 minutes	8 minutes
Temperature (Fahrenheit)	126°	129°	130°

* A temperature of less than 125° F. for barley and 124° for wheat will not kill the smut fungi, and one of more than 129° F. for barley and 131° for wheat will kill the embryo of the grain.

Where steam is not available to keep water at the desired temperature, the treatment can be accomplished easily by using three barrels. In the first, cold water is placed; in the second, water at about 120° F.; and in the third, water at 126° or 129°, depending on whether barley or wheat is to be treated. One-half bushel of seed, in a wire basket or a burlap bag, is dropped first into the water at 120° to warm the seed, and is then plunged into the hotter water, being stirred or shaken constantly. A reliable thermometer must be used during the treatment. If the temperature begins to drop, hot water should be added. When the time is up, the seed should be removed at once and plunged into the cold water. This should be followed immediately with an immersion for three minutes in a cold solution of $\frac{1}{4}$ -per-cent Semesan. The seed should then be spread out to dry. Extra seed should be sown to allow for the swollen condition of treated seed unless it has been thoroughly dried, and for the decrease in percentage of germination caused by the treatment.

Mercuric cyanide

For disinfecting wounds made by cutting out fire-blight cankers, 1 part of mercuric cyanide to 500 parts of water should be used.

Wound dressings

The purpose of a dressing for tree wounds, such as those made by pruning and by removing cankers, is to prevent the entrance of rot-producing organisms into the wood. The ideal dressing is

one which has antiseptic qualities, which will not injure the tissues nor interfere with the healing of the wound, which will adhere well and be durable, which is waterproof, which is easily applied, and which is comparatively cheap and available.

Although there are no ideal dressings available, there are some that possess properties which commend their use. Coal tar, especially the tar produced in the manufacture of gas, has been used successfully on apple and pear trees, although some cases of injury have been reported. If ordinary shellac is first applied to the margin of the wound, or even to the entire surface, there will be no appreciable injury, if any at all, from the application of coal tar. The tar should be heavy enough to give a thick coating.

Asphalt dissolved in varnolene or gasoline, or softened by heat, has been recommended as a satisfactory and durable dressing. The application of a previous coat of shellac is advisable, however.

Bordeaux paint, made by adding sufficient linseed oil to commercial bordeaux powder to make it of the consistency of thick paint, has proved very satisfactory as a wound dressing.

Linseed-oil paint has been recommended, and is used more generally than other dressings. It checks easily and therefore requires repeated applications. The application of a coat of shellac to the wound before applying the paint will make the paint more durable.

GREENHOUSE FUMIGATION

Nicotine fumigation

Fumigation with nicotine is the standard treatment for aphids or green flies, but it is not so effective as cyanide against white flies. The commercial nicotine powders furnish nicotine in the most convenient form for fumigating greenhouses. These powders consist of coarse tobacco impregnated with nicotine, and should contain not less than 12½ per cent, by weight, of pure nicotine. They are effective against plant lice when used at the rate of about ½ to ¾ ounce per 1000 feet of space, and this concentration is safe for most plants. Violets should not be fumigated with nicotine. A good method of distributing the powder is to place a rounded 2½-inch flowerpotful (about 3½ ounces) at intervals along the walks, using one for every 7000 cubic feet. When lighted, the powder smolders and gives off a dense cloud of smoke and nicotine fumes.

Calcium cyanide

Calcium cyanide is now by far the most commonly used form of cyanide for greenhouse fumigation. The grade used for greenhouses is a fine, granular material containing between 40 and 50 per cent of calcium cyanide, by weight. This material takes up moisture from the air and gives off hydrocyanic-acid gas. The quantity to be used will depend on the tightness of the house, the kind of plants in the house, and the insects to be destroyed. Each grower will have to determine by tests the proper dosage for his conditions. In general, ¼ ounce to 1000 cubic feet of space is a safe and effective dosage for the average greenhouse. The calcium cyanide should be carefully weighed out and scattered in a thin layer along the walks, which should be dry. This can be done by means of a jar with a perforated tin screw-cap. Fumigation should be done on still nights, beginning after sundown and keeping the house closed until morning. Since hydrocyanic-acid gas is a deadly poison to man and animals, no one should enter the house until the gas has dispersed. It is safe to enter by morning, and extensive ventilation is not necessary at that time. Plants should not be watered just before or after fumigation.

